Laser Ray Kit

EXPERIMENTS:

Exp-1 Working of Human Eye (Normal eye, near sighted eye and far sighted eye).
Exp-2 Principle of photographic camera.
Exp-3 Principle of Galileo telescope & periscope.
Exp-4 Principle of Kepler telescope.
Exp-5 Principle of spherical aberration.
Exp-6 Principle of Hartley's circle for refraction and reflection

INTRODUCTION

The Laser ray box consists of five independent laser modules. This manual provides information about all the relevant information needed for setting up and operating this device with safety and knowledge even if you are a beginner to laser technology. Please read this manual carefully before operating the laser.

LASER SAFETY INSTRUCTION

Lasers are devices that produce intense beams of coherent light. LASER stands for light amplification by stimulated emission of radiation and describes the process by which a laser beam is generated. The emission can be in the form of visible light or of invisible infrared or ultraviolet radiation. Lasers are used extensively in the measurements and sensing applications, for industrial processing, in medical diagnostics and surgery, for communication using optical fibers and educational purpose. Laser beams may damage eyes severely or may cause blindness if they radiate into the eyes directly or indirectly.

SAFETY RULES

1. Lasers produce a very intense beam of light. Operate them carefully. We are using the class II laser having output less than 1 mW which will not harm the skin.
2. Never look directly into laser aperture while the laser is turned ON. **Permanent eye damage could result**.
3. Never stare into the oncoming beam. Never use magnifier to look at the beam as it travels or when it strikes a surface.
4. Never point a laser at anyone's eyes of face, no matter how far away they are.
5. When using a laser in the classroom or laboratory, always project the beam to areas which people won't enter or pass through.
6. Never leave a laser unattended while it is turned on.
7. Never disassemble or try to adjust the laser's internal components. It may causes electrical shock.

LASER RAY BOX

Laser ray box consists of five independent laser modules with peak wavelength of 635 nm. The laser is very effective in the demonstration of light trace. It also effectively demonstrates the transmission of rays through a combination of optical elements or components. Five clearly visible parallel lines light tracer can be seen when they are collimated by a cylindrical lens.
This product refers to class II laser product. The laser diode modules used in the laser ray box emit visible beams of red light. No infrared, ultraviolet, x-ray or other non-visible radiation is emitted. The one should avoid direct skin and eye exposure to direct laser beam and that from surface reflection. This low power laser can not be used to burn, cut or drill. It should be used only for purpose that was originally produced for.

OPERATION

The bottom of the laser ray box is magnetic which enables the user to use it together with magnetic board, worksheet and optical components from the laser ray kit. Use the laser box with power supply properly.
1. Plug the power adaptor into a grounded circuit.
2. Connect the power adaptor cable to the laser ray box.

TECHNICAL SPECIFICATIONS

Peak wavelength	: 635nm
Operating voltage	: 5V DC
Operating current	: 250mA
Optical power (per beam)	: 0.4-0.8mW
Distance between beams	: 18mm
Dimension (LxWxH)	: 100x75x42mm
Laser product	: class II
Laser type	: Diode
Wavelength	: 635nm
Operating temperature	: 0 - 400C
Storage temperature	: -10 to 500C

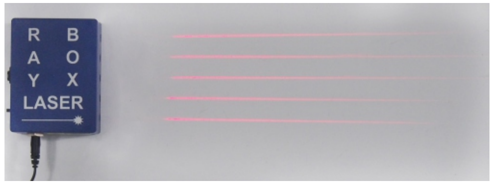
ELECTRICAL SAFETY INSTRUCTION

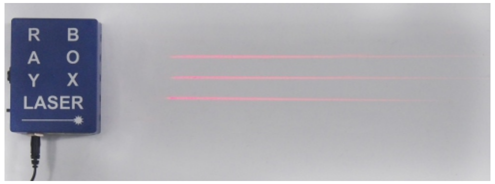
The laser ray box is particularly safe because it is operated at low wattage and current levels. However, as when using any electrical device, you must take certain safety precautions. Do not open the housing of the power adaptor under any circumstances, as this will expose you to unshielded electrical connections.

LASER RADIATION
DO NOT STARE INTO BEAM
CLASS 2 LASER PRODUCT
IEC 60825-1

USING SHADE WITH LASER RAY BOX

The laser ray box produces five parallel beams. The selection switch enables the selection of beams (either single or two outer along with the central beam or three inner) during experiment.





LASER RAY OPTICS KIT

This is a unique, excellent and essential set for practical exercises to demonstrate the basic ray optics. This set enables students to understand basic principle of ray optics - reflection, refraction, transmission. In classroom, students can construct simple optical ray layout using worksheet. For e.g., worksheet human eye helps to understand why some of them have to wear glasses, worksheet telescope helps to understand how an object far from observer seems etc. This set has been designed to be table used. All elements are easily attached to a magnetic board. This kit allows very clearly understanding the following optical effects and principles:

1. Transmission of the light through the convex and concave lens.
2. Transmission effect of an optical prism.
3. Reflection on the planar convex and concave mirror,
4. Reflection of the light.
5. Refractive index value.
6. Function of healthy, short sighted and far sighted vision and correction of these aberrations by glasses.
7. Demonstrates the function of Galileo and Kepler telescopes.
8. Demonstrates the function of photo camera.

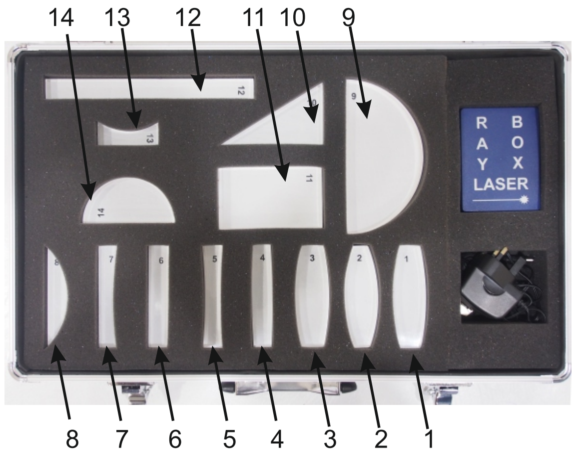
CONTENTS OF KIT

1) Laser Ray Box

Laser Ray Box is a laser light source with a wavelength of 635 nm and power of 5 x 1mW. Using 5 laser rays collimated by a cylindrical lens, results in five parallel clearly visible line light traces. The bottom of the Laser Ray Box is magnetic which enables to use the Laser Ray Box together with the magnetic board, sheets and optical models.

2) Ray Optics Demonstration Set

1	Biconvex lens no 1.
2	Biconvex lens no 2.
3	Biconvex lens no 3.
4	Biconvex lens no 4.
5	Biconcave lens no 5.
6	Plane mirror
7	Concave mirror
8	Convex mirror
9	Plane convex lens R=75mm
10	Prism
11	Rectangular plane
12	Optical fiber
13	Plane concave lens
14	Plane convex lens R=45mm



3) Working sheets

This is very simple and quick preparation of demonstration. The demonstration is ready quickly if the desired objects are located on assigned positions on the sheet.

a) Model of the human eye
b) Photo camera
c) Galileo telescope
d) Kepler telescope
e) Effect of the spherical aberration of a lens, and its correction
f) Hartle’s circle for Refraction and reflection

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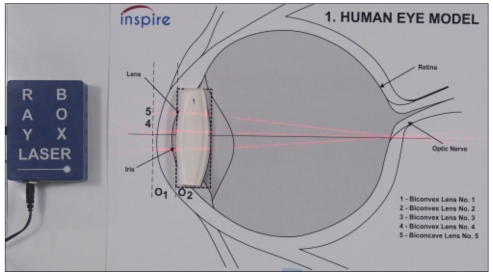
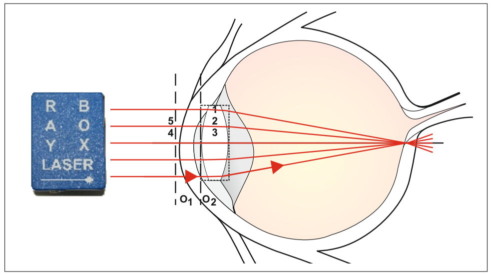
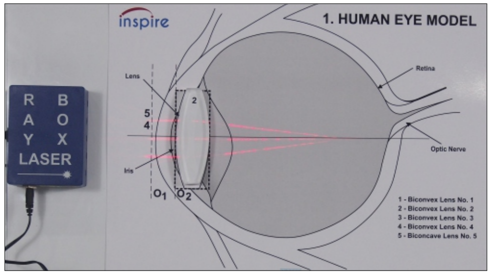
EXPERIMENT-1: WORKING OF HUMAN EYE
Model of Human Eye (Working sheet-1)

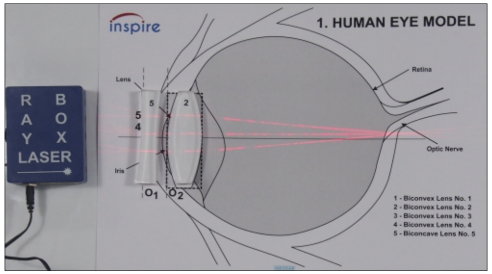
Normal eye: Place the eye lens no. 1 directly behind the line O2. Parallel rays to the optical axis intersect after passing through uncorrected eye lens at retina.

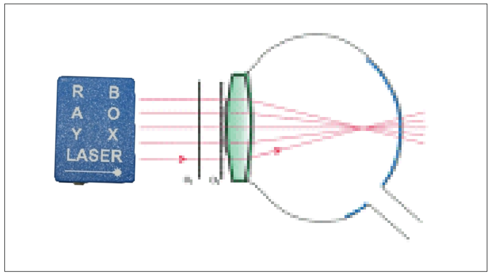


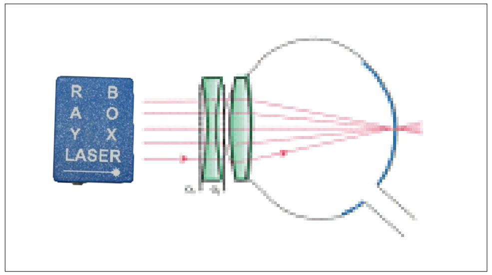


Near sighted eye: Place the eye lens no 2 directly the behind the line O2 and correction lens no 5 between the line O1 and O2. Display rays parallel to the optical axis intersect after passing through uncorrected eye lens at one point of the optical axis before the retina.

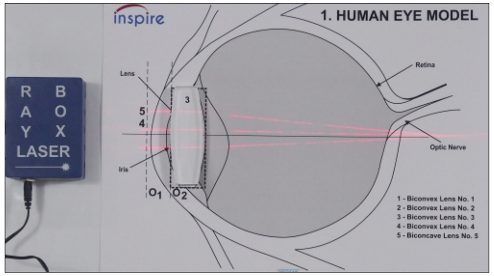


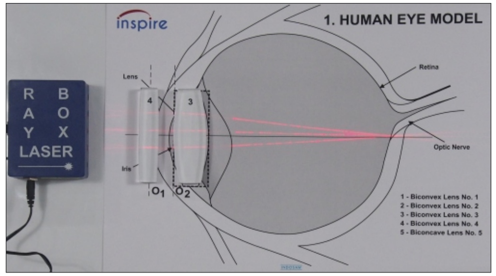


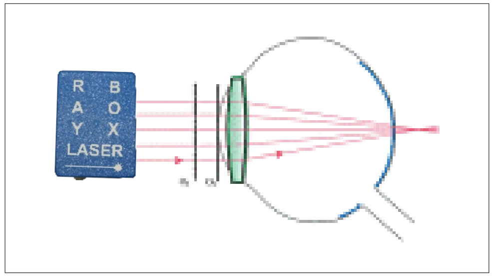


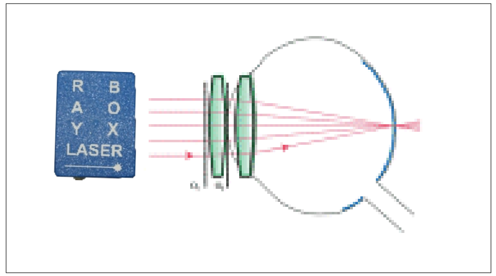


Far sighted eye: Place the eye lens no 3 directly the line O2 and correction lens no 4 between the line O1 and O2. Display rays parallel to the optical axis intersect after passing through uncorrected eye lens at one point of the optical axis after the retina. The focal length f' of the system of eye lens and the correction lens is $f' = (f_1' f_2') / (f_1' + f_2')$, where f_1' is the focal length of the eye lens and f_2' is focal length of the correction lens.



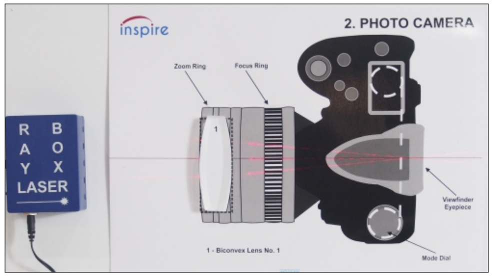


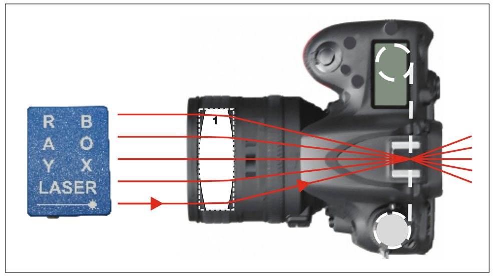




EXPERIMENT-2: PRINCIPLE OF PHOTOGRAPHIC CAMERA
Model of photo camera (Working sheet-2)

The lens of the camera is a convergent optical system. The figure which appears on the near part of the camera is real and reversed. It is directed onto the optical material.





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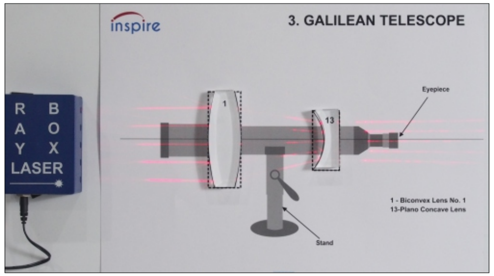
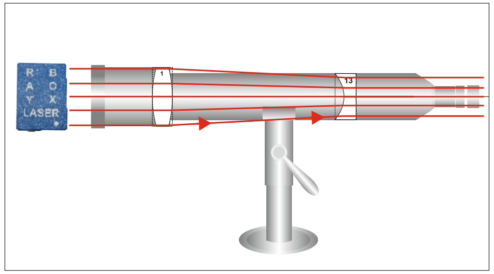
EXPERIMENT-3: PRINCIPLE OF GALILEO TELESCOPE

Model of Galileo telescope & periscope (Working sheet -3)

The incident angle can be changed by lens no 1. The figure is created by parallel rays by lens no 13, so it is unreal and magnified. If the to ray of incident beam is blocked, the top ray of the output beam disappears.

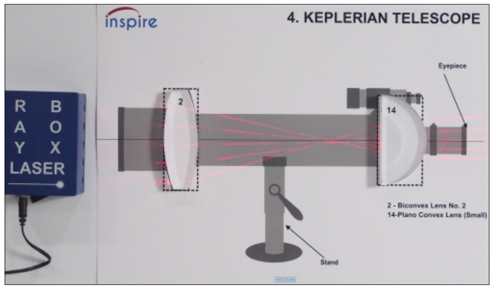


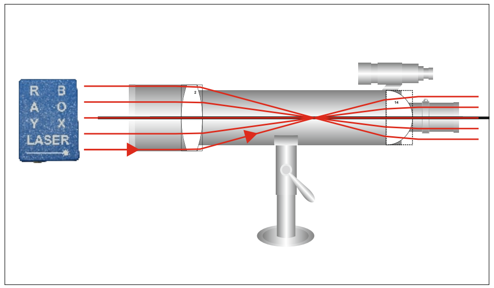


EXPERIMENT-4: PRINCIPLE OF KEPLER TELESCOPE

Model of Kepler telescope (Working sheet- 4)

The Kepler's telescope is reversed. This can be verified by blocking a marginal ray lens no 2. If top ray blocked, in the output ray the bottom ray disappears lens no 14. It's unreal and magnified.



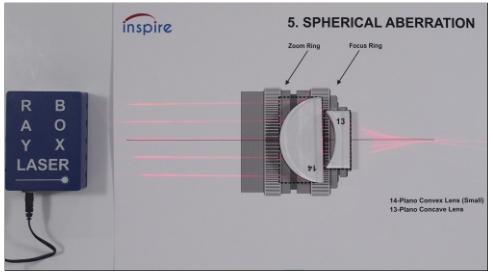


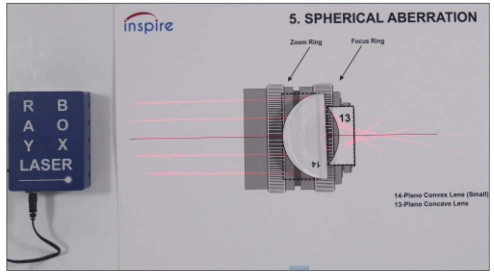
EXPERIMENT-5: PRINCIPLE OF SPHERICAL ABERRATION

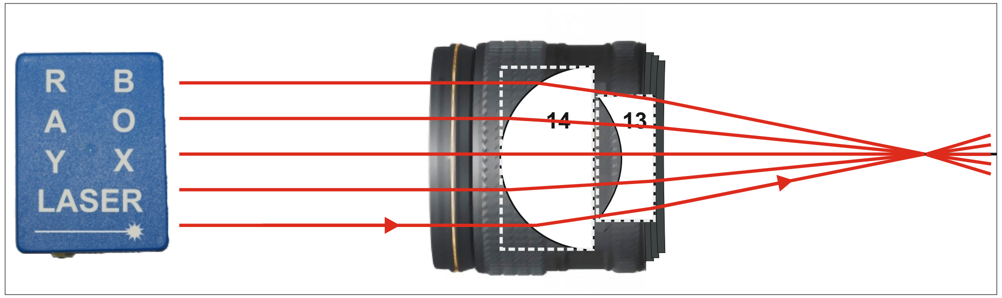
Spherical aberration is the failure of a lens or mirror to focus the marginal rays and paraxial rays at same point.

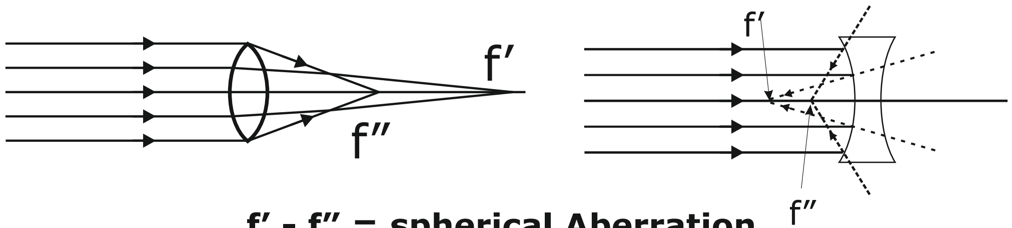
Model of Spherical aberration (Working sheet -5)

The spherical aberrations of convergent and divergent lenses have an inverse effect. By a convenient combination of these two types of lenses the aberration can be corrected. The aberration df=f'-f", where f' focal length of marginal rays, and f" focal length of paraxial rays. In the case of a convergent lens no 14 and divergent lens no 13 the aberration are plus sign and minus sign respectively.









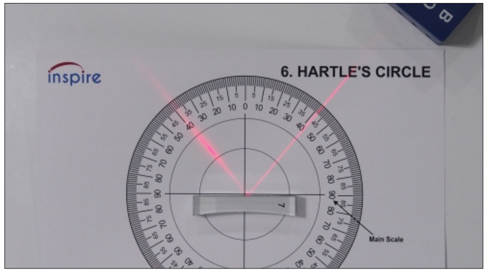
f′ - f″ = spherical Aberration

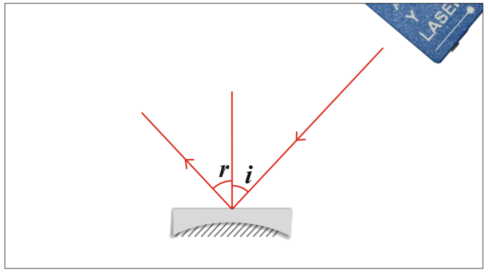
EXPERIMENT-6: PRINCIPLE OF HARTLEY'S CIRCLE FOR REFRACTION AND REFLECTION

6. Hartley's circle for Refraction and reflection (Working sheet-6)

6.1 Reflections on plane mirror

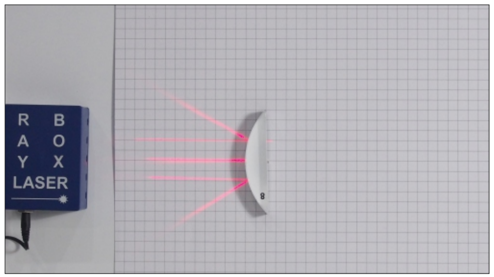
When a light ray encroach a plane mirror no 7 at an angle (i), it's reflected at the same angle (r), i.e i = r. Both angles are measured from the perpendicular line to the mirror plane known as law of reflection.

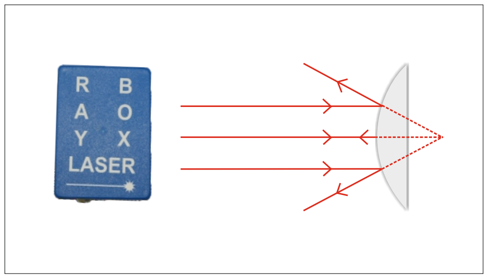




6.2 Reflections on convex mirror

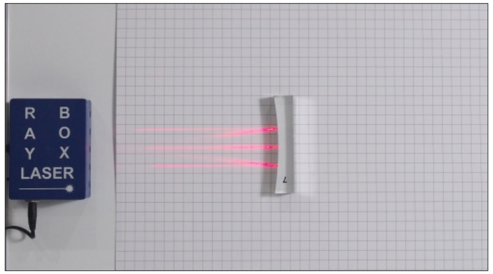
a) When a ray, which are parallel to the optical axis encroach the convex mirror no 8, the reflected rays appear to start from one point on the right side behind the mirror. This point is referred to as focus and length of line from focus to mirror center determines the focal length f of the convex mirror. The radius of curvature can be obtained from the formula r = 2f. (Distance of the center of curvature = 2 x distance of the focus.)

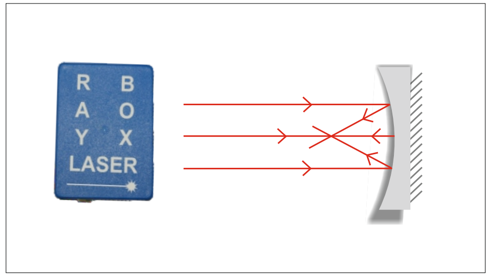




6.3 Reflections on Concave Mirror

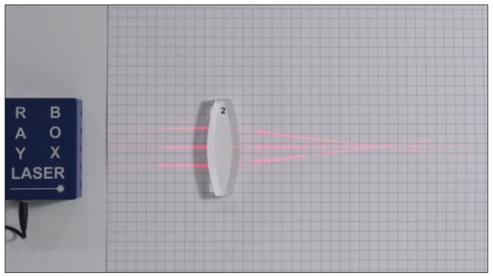
a) When a rays, which are parallel to the optical axis encroach the concave mirror no 7, the reflected rays meet at one point on the same side of the mirror. This point is referred to as focus and length of line from focus to mirror center determines the focal length f of the convex mirror. The radius of curvature can be obtained from the formula r = 2f. (Distance of the center of curvature = 2 x distance of the focus.)

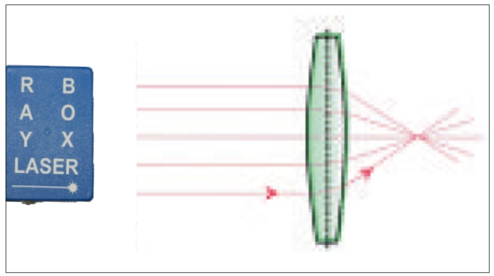




6.4 Refraction by Convex Lens

When a rays, which are parallel to the principal axis of the lens no 1, 2, & 3 after refraction meet at one point on the other side of the lens. This point is referred to as second principal focus and length of line from focus to optical center determines the focal length f of the convex lens. The focal length of lens is defined as $1/f = (n-1)(1/R_1-1/R_2)$, where n is refractive index and R radius of curvature. In case of thick lens the focal length can be defined as $1/f = (n-1)(1/R_1-1/R_2) + (n-1)(C_T/nR_1R_2)$, where C_T is central thickness.





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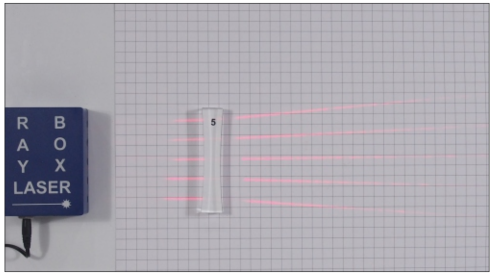
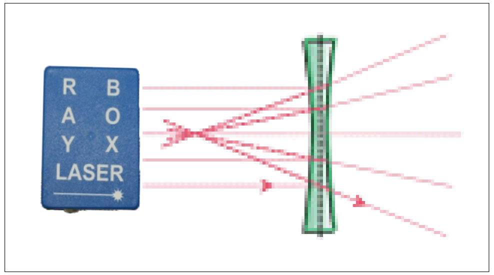
6.5 Refraction by Concave Lens

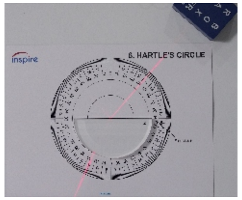
When a rays, which are parallel to the principal axis of the lens no 5 after refraction appear to start from one point on the same side of the lens. This point is referred to as first principal focus and length of line from focus to optical center determines the focal length f of the concave lens. The focal length of lens is defined as $1/f = (n-1)(1/R_1-1/R_2)$, where n is refractive index and R radius of curvature. In case of Thick lens the focal length can be defined as $1/f = (n-1)(1/R_1-1/R_2) + (n-1)(C_T/nR_1R_2)$, where C_T is central thickness.

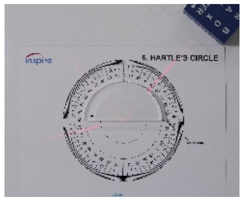


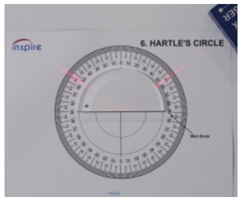


6.6 Refraction by Plane Convex Lens

Place the plane convex lens no 9 (r=75mm) on Hartley disk. A single laser beam is selected. This beam is incident at an angle i to the normal on the plane surface. A part of beam gets reflect back into the same medium (Reflected Ray) while the rest enter to other medium (Refracted ray). Now measuring the incident angle, reflected angle and refracted angle, the law of reflection and refraction can be verified.







Limited Angle:

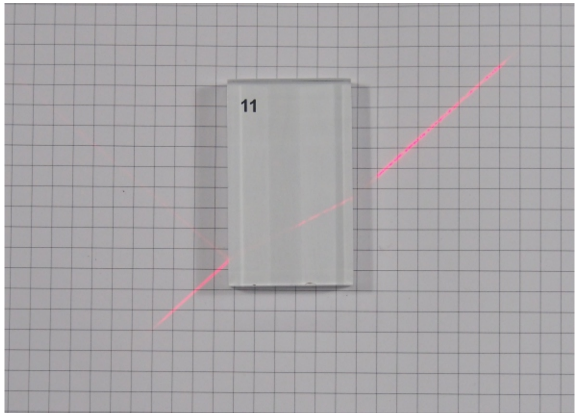
Now change the spherical surface along the side of incident ray and vary the angle of incident and find out the limited angle.

Absolute reflection

At a particular angle of incident the light ray reflect back into the same medium known as absolute reflection.

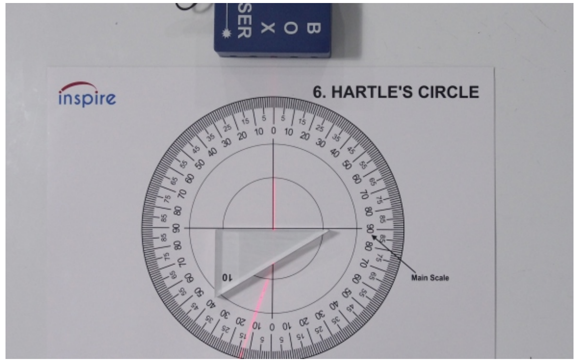
6.7 Refraction by Rectangular Plane

When a beam of light encounters another transparent medium no 11, a part of light gets reflected back into the first medium while the rest enters the other. The direction of propagation of incident ray of light that enters the other medium, changes at the interface of the two media. This phenomenon is known as refraction. Its well defined by snell's law i.e sin i / sin r = n, where I is the incident angle, r is the refracted angle and n is the refractive index of the medium. The lateral shift also may be measured using this rectangular slab.



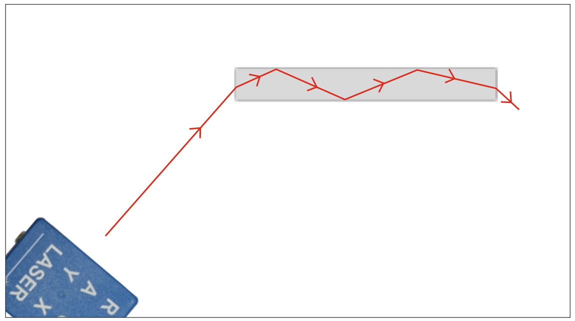
6.8 Transmission Effect of a Optical Prism

Prism no 10 designed to bend light by 90°or by 180° make use of total internal reflection. In this case student can identify how the prism works and its change in characteristics on different angle of incident beam.



6.9 Absolute reflection in the optical fiber (Total internal reflection)

Optics pipes no 12 now days are extensively used for transmitting the signals through long distance. This design is based on the phenomenon of total internal reflection.



EXPERIMENT-7: PRINCIPLE OF TELESCOPE

A periscope is a device which is used for for observation when an obstacle prevents direct line-of-sight observation from an observer's current position.

In its simplest form, it consists of two parallel mirrors. Light from the object is incident on the first mirror which is positioned at 45 degree. After reflection from the first mirror, the light beam is then incident on the second mirror at 45 degree. After reflection from the second mirror, light beams finally enter the eye.