Hartl's disk with laser

Article code: QLG005

Description

For exploring the various concepts of optics involving reflection and refraction using ray tracing technique. Comprises a sheet metal disc, about 30cm in diameter, painted white at the top with clamping assembly at its underside for mounting it on a vertical support rod in either of horizontal or vertical plane and is rotatable about its axis. The upper side of disc has a circular scale along its rim graduated 90º-0-90º- 0-90º × 1º and divides the disc in four equal quadrants with its center clearly marked. Shapes of various optical elements also clearly marked on the disc to facilitate their placement while performing experiments. The clamp at the underside has metal bar projecting radially outside with adjustable lamp holder mounted at the other end with an adjustable collimating lens to get divergent, convergent or parallel beam as required. A rotatable disc attached in front of collimating lens provides option of single, double, triple or quadruple slits for range of experiments. Complete assembly mounted on stable cast metal heavy base. Supplied complete with reflective components – one each of plane glass mirror, polished semi-circular cylindrical mirror; and set of 6 refractive components, acrylic blocks (prisms) – one each of semi-circular, bi-convex, bi-concave, right angled prism, equilateral prism and trapezoidal prism. All optical elements provided with powerful magnets at their bottom for placing them securely on the disc in either of horizontal or vertical disc position. The bottoms of all refractive components are frosted to minimize internal reflections and revealing the path of light as it passes through.

Theory

Light

Light is electromagnetic radiation within a certain portion of the electromagnetic spectrum. The word usually refers to visible light, which is visible to the human eye and is responsible for the sense of sight.

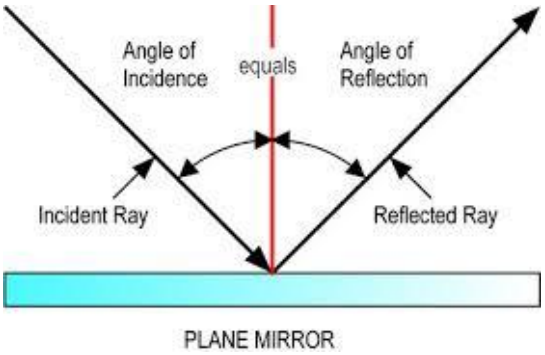
Mirror

Mirrors are very smooth surfaces usually made of polished metal or silver-coated glass. Mirrors come in a variety of types. Some mirrors have a flat surface while others have a curved surface.

Reflection of light

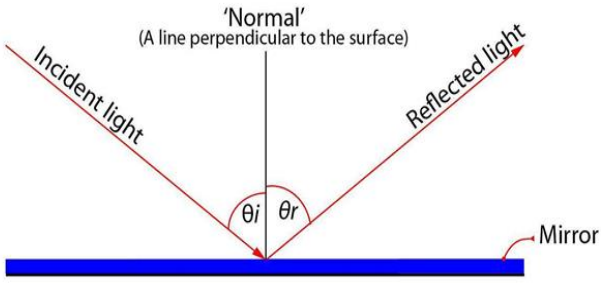
It is the phenomenon of change in the path of light ray without any change in medium.

Here in the diagram a ray of light incident on the plane mirror at some angle called angle of incident with normal. After falling on the mirror the light reflected at the same angle and this angle is called angle of reflection.



Law of reflection

1. The law of reflection states that the incident ray, the reflected ray, and the normal to the surface of the mirror all lie in the same plane.

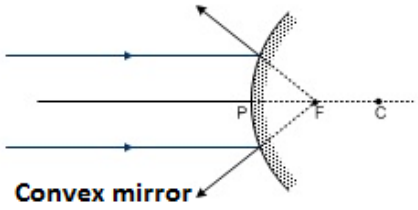


2. Angle of incidence equals angle of reflection

$$\theta_i = \theta_r$$

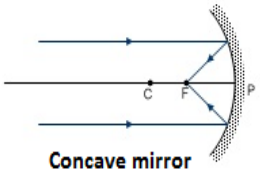
Convex mirror

A convex mirror is curved like the back of a spoon. The edges of the mirror curve away from you. A convex mirror makes reflected light rays spread out. They seem to come to a point behind the mirror, forming a smaller, and virtual image. Convex mirrors are used on vehicles as the side-view mirrors to help drivers have a wider view of surrounding cars to the side and at the back of the vehicle.



Concave mirror

A concave mirror is curved like the inside of the bowl or a spoon. The edges of the mirror curve toward you. Concave mirrors reflect light rays to a point in space called the focus. The focus is in front of the mirror. The distance from the center of the mirror to the focus is the focal length.



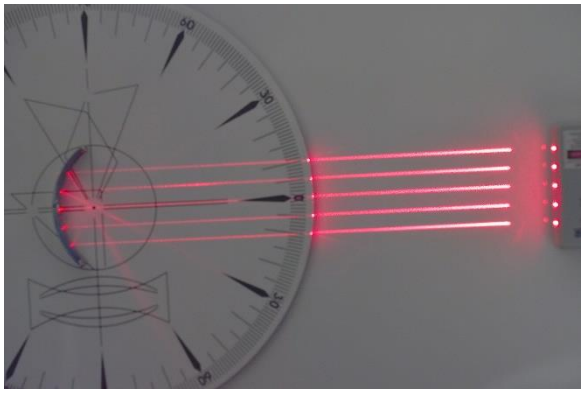
Experiment 1: To study the reflection and divergence of light from a spherical mirrors.

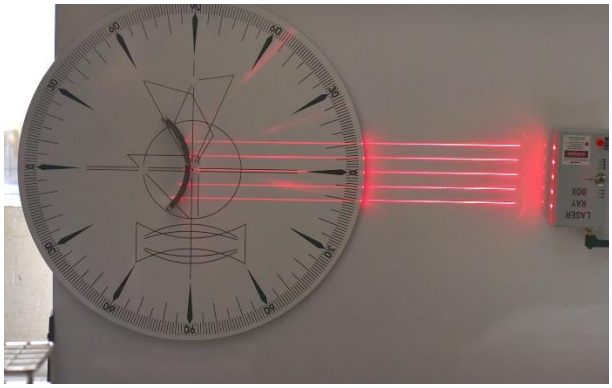
Components required:

- Laser box (5 Slit)
- DC Power Supply 5V
- Polished semicircular cylindrical mirror
- Magnetic board with disc

Procedure:

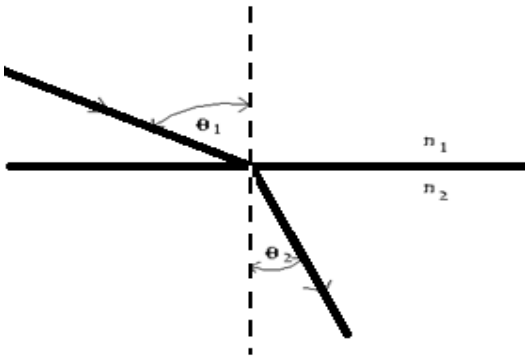
1. Place the laser box on the magnetic board and adjust the switch at 5 slits.
2. Connect the laser box with mains using adapter.
3. Stick the semicircular mirror on the disc in the center.
4. When light fall on the concave mirror/convex mirror get reflected and converges/diverges as shown in the figure below.





Refraction of light:

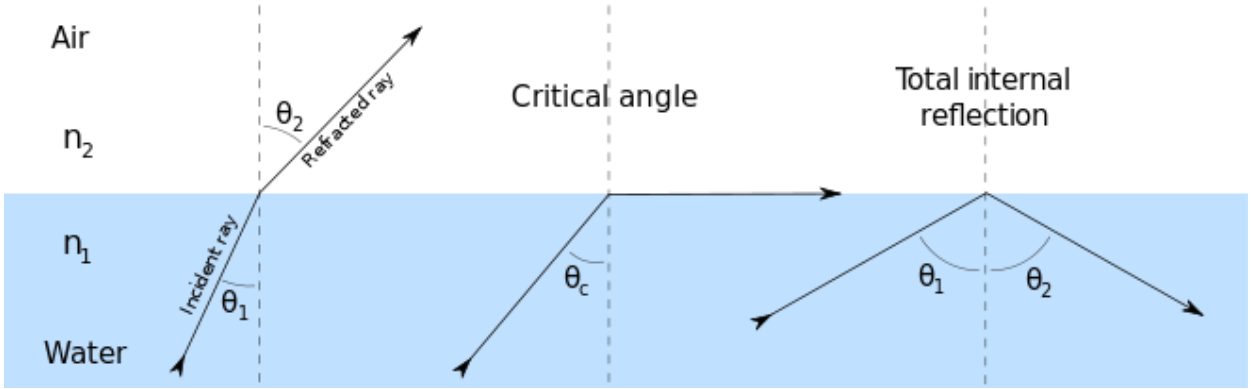
When a wave crosses a boundary between medium 1 and medium 2, the wave changes direction because it changes velocity. Frequency remains constant. Velocity changes as a result of wavelength change. This phenomenon is called refraction of light.



Total Internal Reflection:

Total internal reflection, in physics, complete reflection of a ray of light within a medium such as water or glass from the surrounding surfaces back into the medium. The phenomenon occurs if the angle of incidence is greater than a certain limiting angle, called the critical angle.

In general, total internal reflection takes place at the boundary between two transparent media when a ray of light in a medium of higher index of refraction approaches the other medium at an angle of incidence greater than the critical angle. For a water-air surface the critical angle is 48.5°.



Experiment 2: Refraction of light through semicircular Disc.

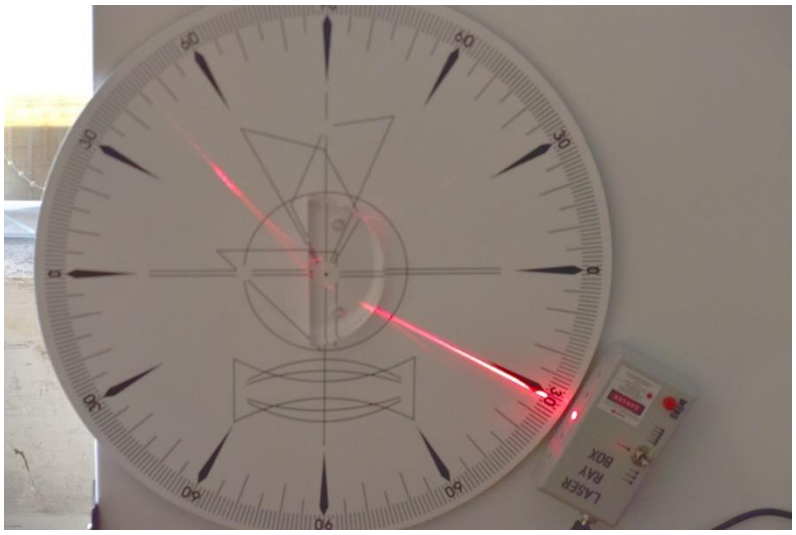
Components required:

- Laser Box
- DC Power Supply 5V
- Semicircular block
- Magnetic board with disc

Procedure:

1. Place the laser box on disc and adjust the switch at single slit.
2. Place the semicircular block in front of the laser box.

3. Incident the light normally on the semicircular block, the light passed without deflecting.
4. Now Incident the ray of light on the semicircular at some angle, the ray get refracted from the block.



Experiment 3: To study total internal reflection through a semicircular block.

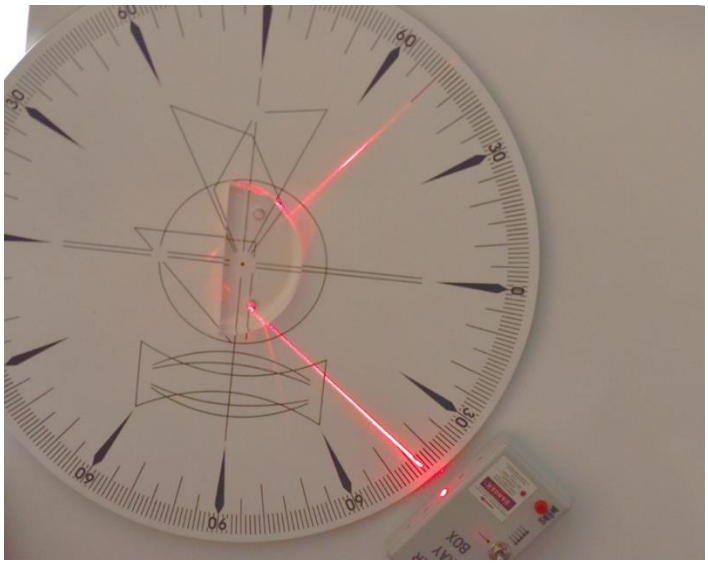
Components required:

- Laser Box
- DC Power Supply 5V
- Semicircular Block.
- Magnetic board with disc

Procedure:

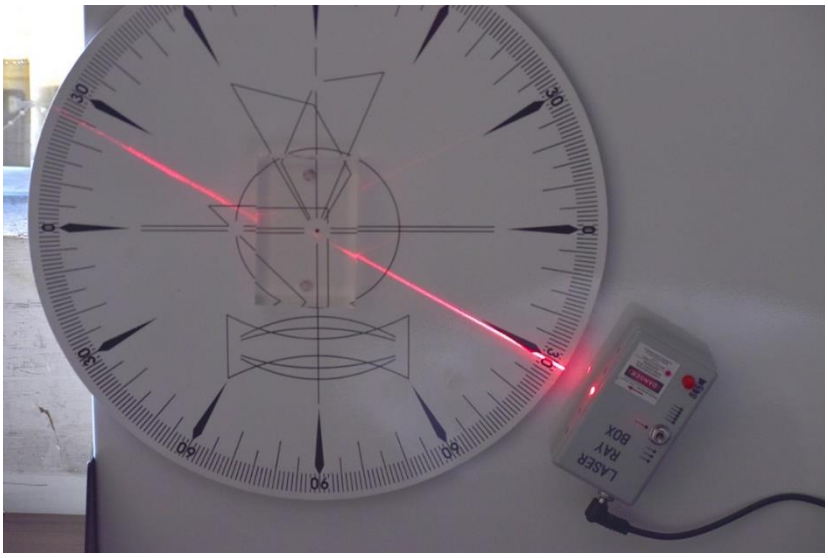
1. Place the laser box on white board and adjust the switch at single slit.
2. Place the semicircular block in front of the laser box.
3. Incident the light normally on the semicircular block, the light passed without deflecting.

4. As its angle of incident within the glass is 45^{o} which is greater than the critical angle, the ray is totally internally reflected and turned through 90^{o} at each reflection as shown in figure below.

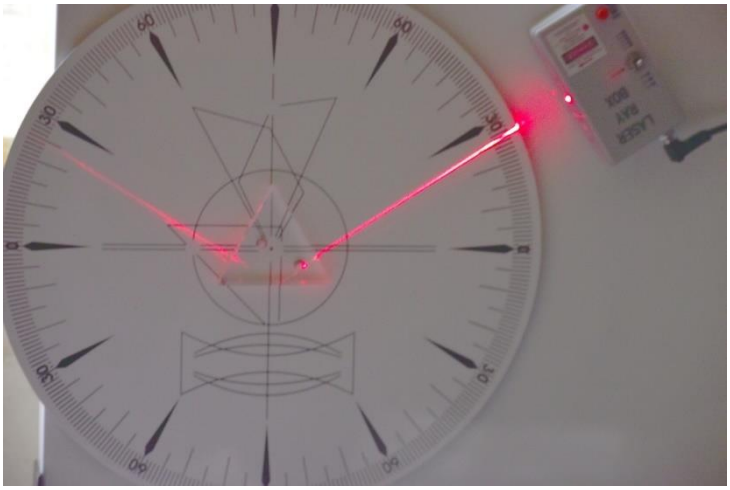


Same phenomenon can be observed in the following objects

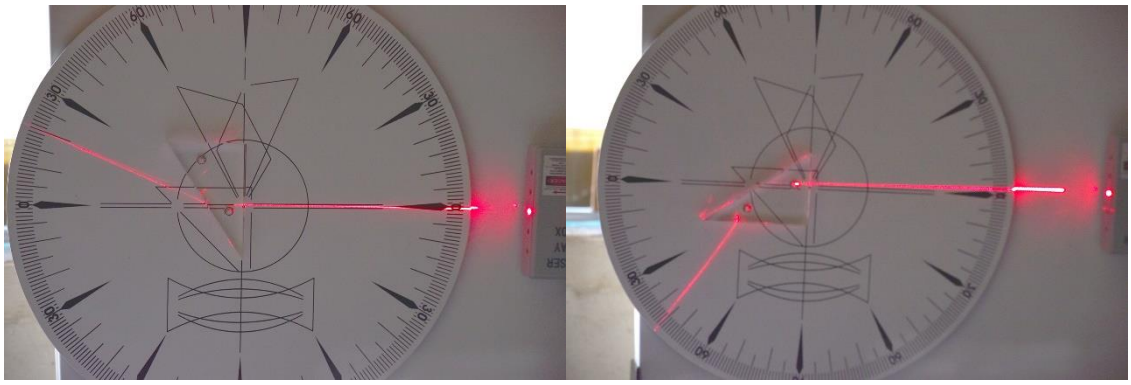
Refraction through rectangular glass slab:



Refraction through equilateral prism:



Refraction through right angle prism:



Experiment 4: To observe the path of rays in convex lens.

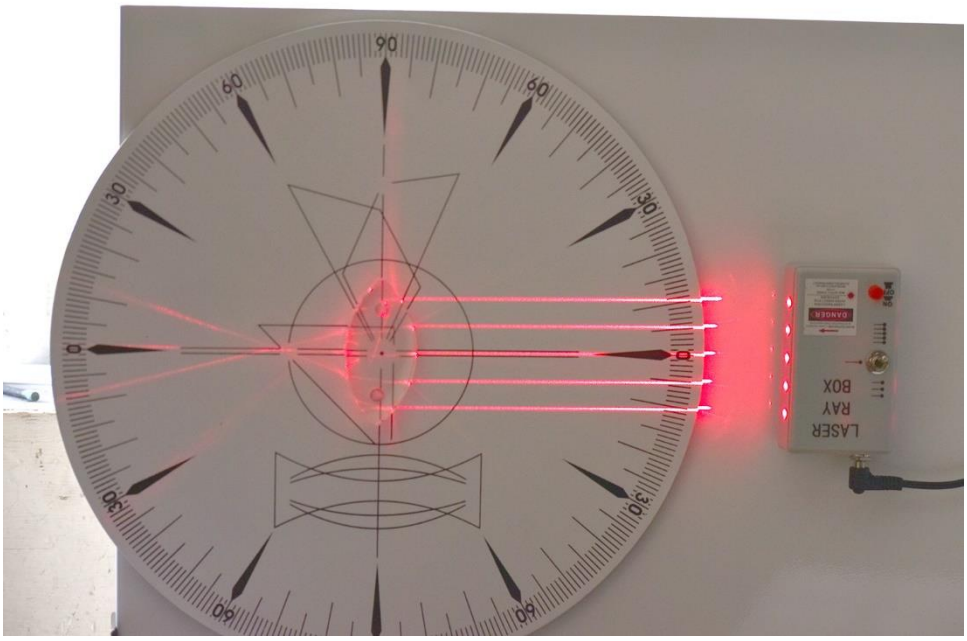
Components required:

- Laser Box
- DC Power Supply 5V
- Convex lens
- Magnetic board with disc

Procedure:

1. Place the laser box on magnetic board and adjust the switch at five slits.

2. Place the convex lens in front of the laser box in the middle of disc.
3. Incident the light normally on the convex lens.
4. As the light rays falls on the lens the light rays converges at one point shown in the diagram.



Experiment 5: To observe path of rays in concave lens.

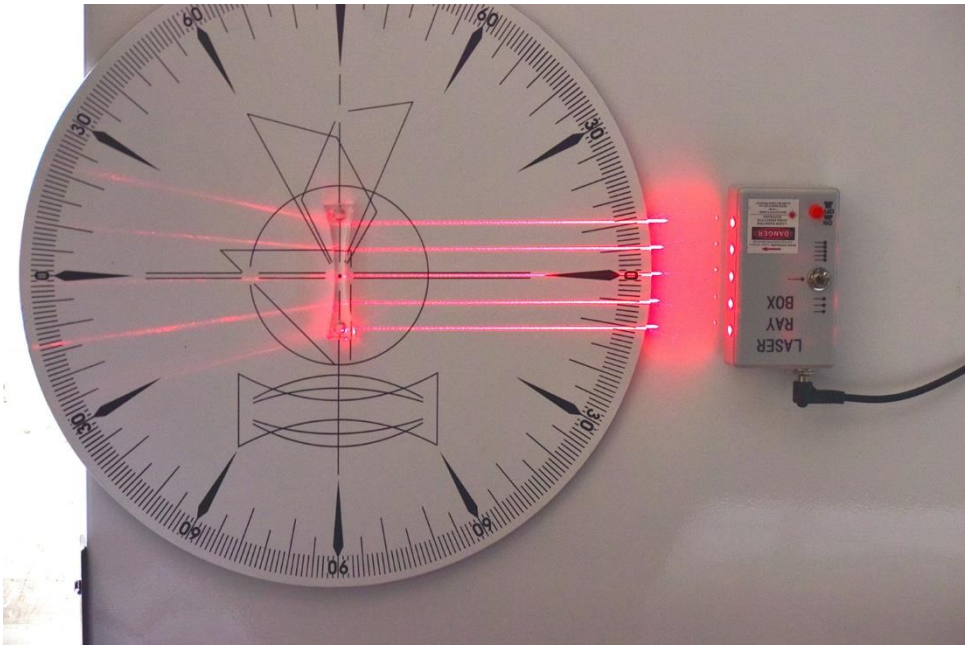
Components required:

- Laser Box
- DC Power Supply 5V
- Concave lens
- Magnetic board with disc

Procedure:

1. Place the laser box on magnetic board and adjust the switch at five slits.
2. Place the concave lens in front of the laser box in the middle of disc.
3. Incident the light normally on the concave lens.

4. As the light rays falls on the lens the light rays diverge in different directions shown in the diagram.



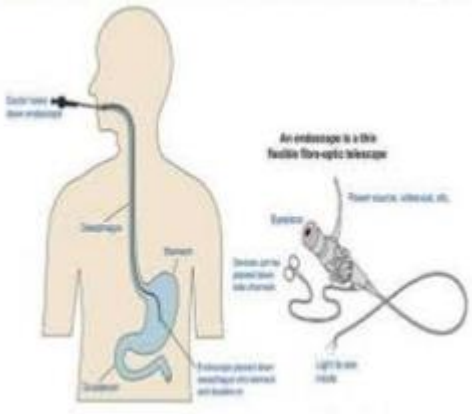
Application of concave mirror:

As a shaving mirror	
As a dentist mirror	
As a makeup mirror	
As a solar cooker	

Application of convex mirror:

As a side mirror in vehicle	
In hallways of different building	

Application of TIR (total internal reflection)

In telecommunication	
In medicine - endoscopes	

Application of concave lens:

Spy hole in door	
In flashlight	

Application of convex lens:

Magnifying glass	
In microscopes