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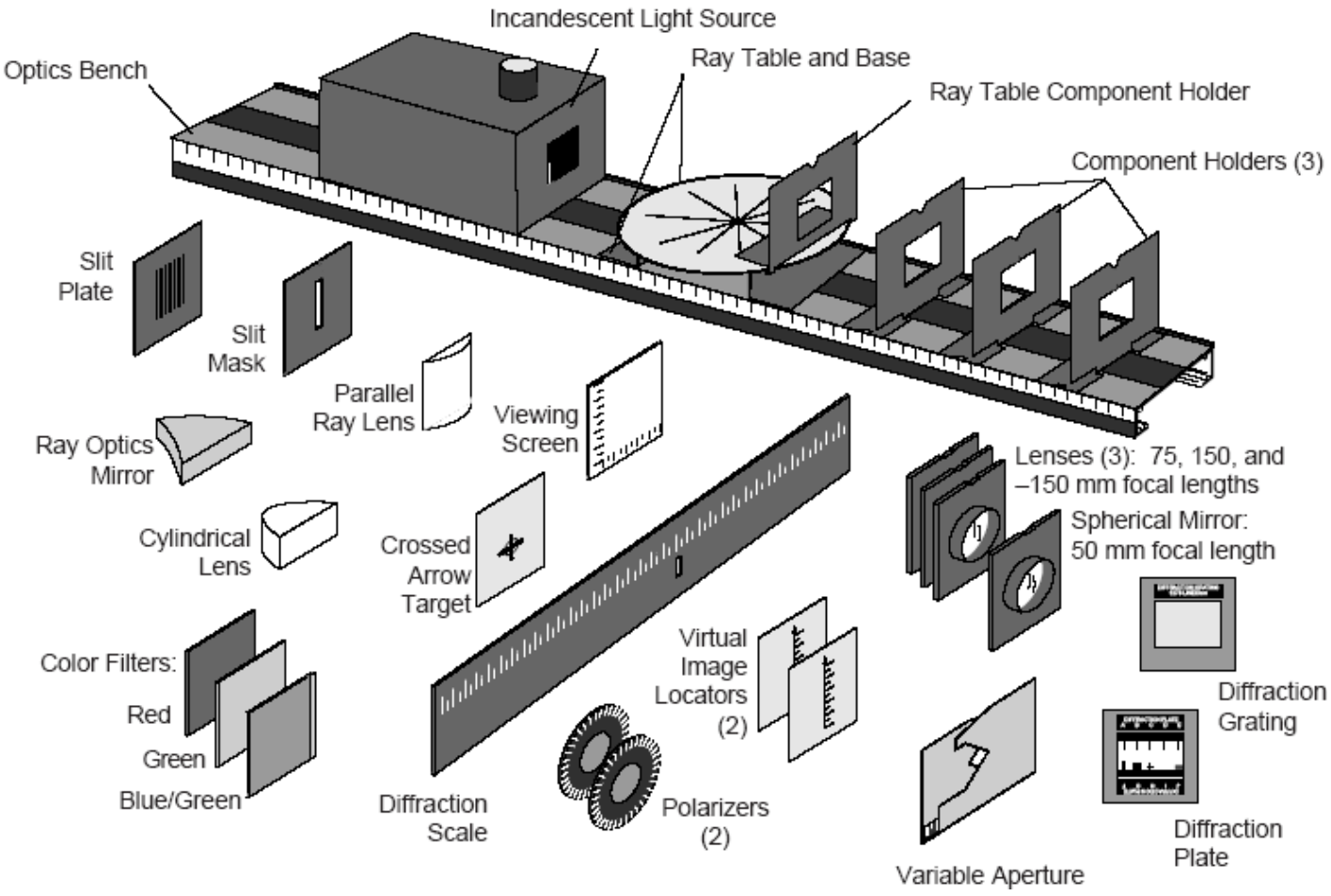
Lab 1L

Reflection, Refraction, Total Internal Reflection, & Dispersion

Equipment

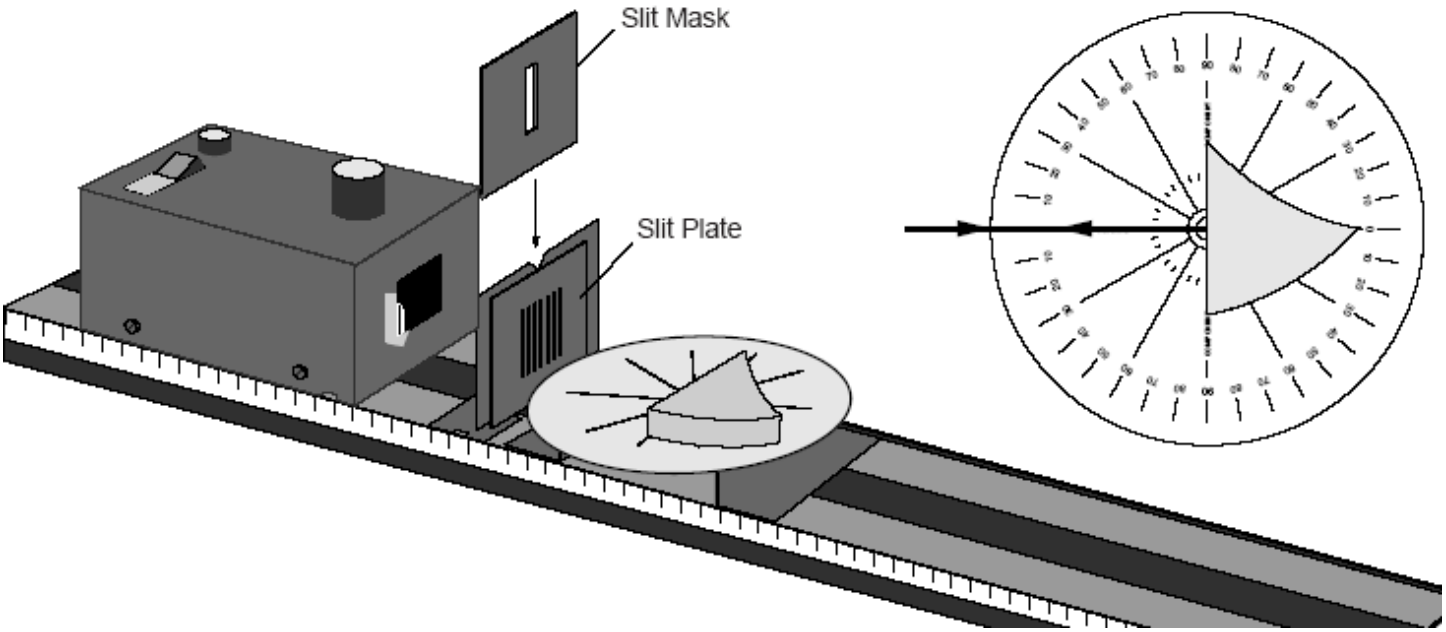


Not all of the equipment shown above will be used during the activities outlined in this procedure. A glass beaker full of water will also be necessary to perform the Total Internal Reflection activity.

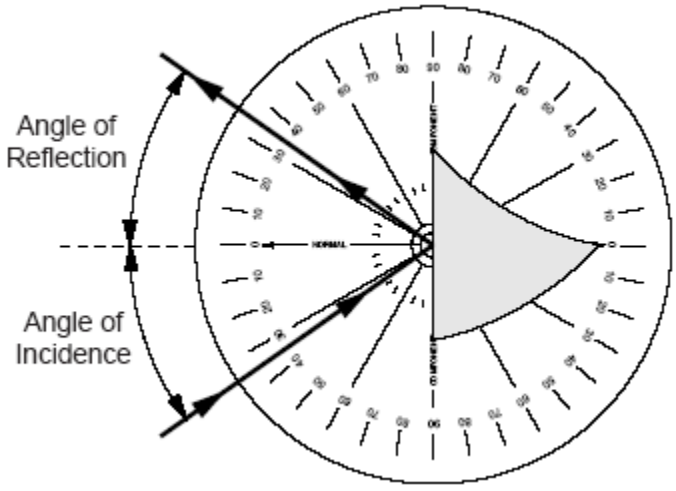
The Law of Reflection

The shape and location of the image created by reflection from a mirror of any shape is determined by just a few simple principles. One of these principles you already know: *light propagates in a straight line*. You will have an opportunity to learn the remaining principles in a series of activities over the next couple of weeks.

To determine the basic principles underlying any phenomenon, it is best to observe the phenomenon in its simplest form. In this activity, you will observe the reflection of a single ray of light from a plane mirror. The principles you discover will be applied to more complicated examples of reflection in future activities.



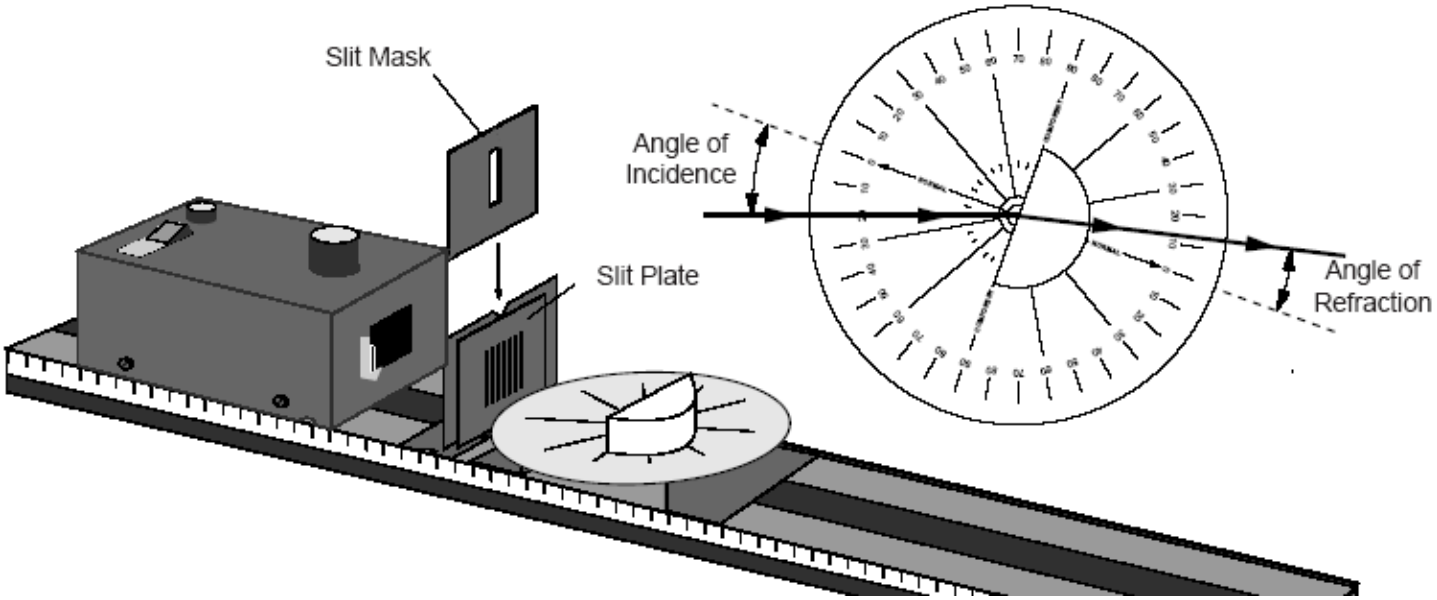
Set up the optics bench with the components shown above. Note that the base of the ray table should be placed on the optics bench such that the table is tilted towards the light source. Adjust the slit plate and slit mask such that a single ray of light is visible on the ray table. The ray of light should be aligned with the bold arrow on the ray table labeled NORMAL. The knob on the light source can be used to fine tune the alignment; however course adjustments must be made by adjusting the slit plate and slit mask. Align the flat edge of the mirror with the line on the ray table labeled COMPONENT. Now the flat surface of the mirror should be perpendicular or normal to the ray of light.



By gently rotating the ray table, the angle of incidence can be changed. Complete the table and questions on the Data Sheet under the section labeled The Law of Reflection. The trials should be conducted such that data is obtained when the incident ray is located on either side of the normal.

The Law of Refraction

As you have seen, the direction of light propagation may change abruptly when the light encounters a reflective surface such as a mirror. Of course, we call this change REFLECTION. The direction of a ray of light will also change when the light passes from one medium of propagation into another. In this case, the change of direction is called REFRACTION.



Replace the mirror from the previous set-up with the cylindrical lens. Again the flat edge of the lens should be aligned with the line on the ray table labeled COMPONENT. It is also critical that the radius of the cylindrical lens be aligned with the line labeled NORMAL. If the lens is properly aligned, the radial lines extending from the center of the ray table will be perpendicular to the surface of the curved edge of the cylindrical lens.

By gently rotating the ray table, the angle of incidence can be changed. Complete the table and questions on the Data Sheet under the section labeled The Law of Reflection. The trials should be conducted such that data is obtained when the incident ray is located on either side of the normal.

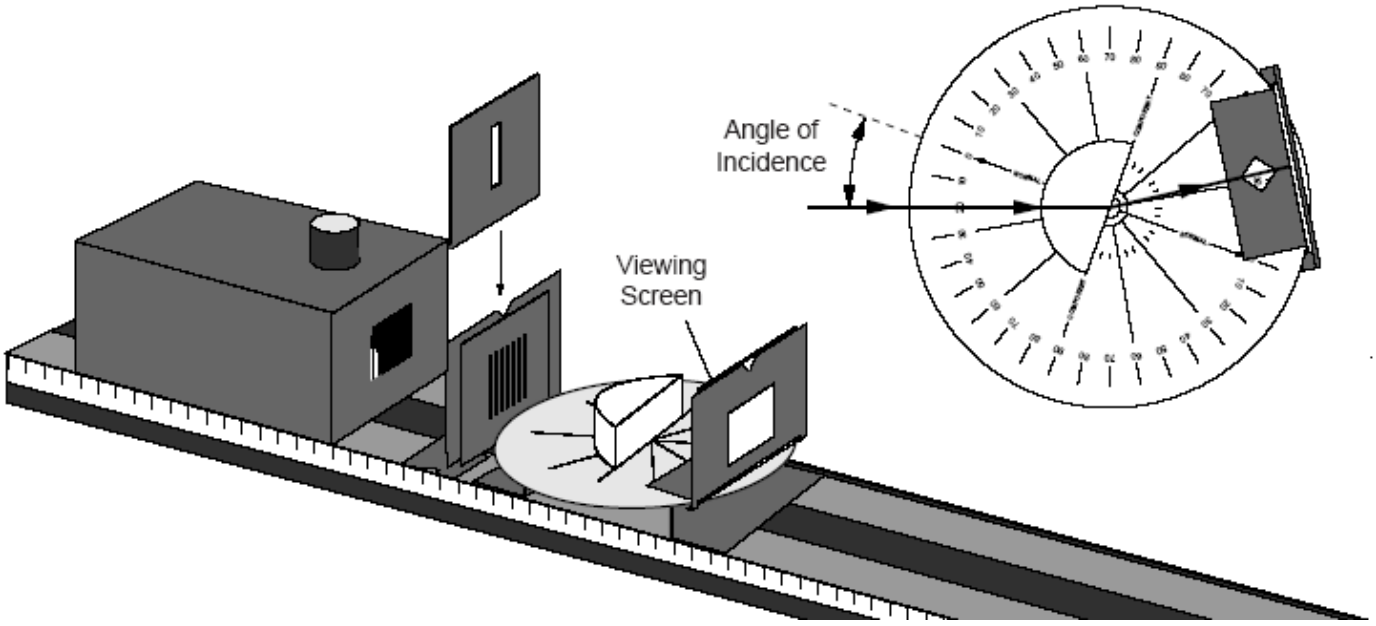
Reversibility

While investigating the Law of Refraction, you determined the relationship that exists between the angle of incidence and the angle of refraction for light passing from air into a more optically dense medium (the Cylindrical Lens). However, what relationship exists between angle of incidence and the angle of refraction for light passing from a more optically dense medium into air?

Using the same set-up as in the Law of Refraction, rotate the ray table 180^0 such that the incident ray will strike the curved edge of the cylindrical lens. Complete the table and questions on the Data Sheet under the section labeled The Law of Reflection. The trials should be conducted such that data is obtained when the incident ray is located on either side of the normal.

Dispersion

A phenomena related to refraction is Dispersion. Dispersion introduces a complication to the Law of Refraction, which is that the index of refraction is dependent upon wavelength for most materials.



By adding a ray table component holder and a viewing screen, the phenomena of dispersions can be readily seen. With the incident ray striking the curved edge of the cylindrical lens, slowly increase the angle of incidence by rotating the ray table until the refracted ray begins to split into the spectrum. The spectrum should be seen on the viewing screen. Answer the questions on the Data Sheet in the Dispersion Section.

Total Internal Reflection

Total Internal Refraction is another phenomena related to the Law of Refraction. Under certain conditions, light striking an interface between two transparent medias with different indexes of refraction cannot pass through the interface.

Use the same set-up as the Dispersion activity. With the incident ray striking the curved edge of the cylindrical lens, slowly increase the angle of incidence by rotating the ray table until the refracted ray is no longer exiting the flat edge of the cylindrical lens. As you turn the ray table, you should notice a reflected ray begin to appear. Find the minimum angle of incidence that will result in the refracted ray disappearing.

Answer the questions on the Data Sheet in the Total Internal Reflection Section.

Name: _____ Name: _____

Name: _____ Name: _____

Data Sheet
Lab 1L
Reflection, Refraction, Total Internal Reflection, & Dispersion

The Law of Reflection

Below the Normal		Above the Normal	
Angle of Incidence	Angle of Reflection	Angle of Incidence	Angle of Reflection
10^0		10^0	
30^0		30^0	
50^0		50^0	
70^0		70^0	

Are the results for the two trials the same? If not, to what do you attribute the differences? _____

_____

_____

What relationship holds between the angle of incidence and the angle of reflection? _____

_____

_____

Does the reflected ray always lie in the plane of incidence? _____

_____

_____

The Law of Refraction

When the incident light ray is aligned with the NORMAL line and the cylindrical lens is aligned with the COMPONENT line, the flat edge of the cylindrical lens is perpendicular to the incident ray of light.

Is the light ray bent as it enters the lens? Explain. _____

_____

Is the light ray bent as it leaves the lens? Explain. _____

_____

_____

_____

Complete the following table.

Below the Normal		Above the Normal				
Angle of Incidence	Angle of Refraction	Angle of Incidence	Angle of Refraction	Average Angle of Refraction	Sine of Incident Angle	Sine of Average Refraction Angle
0^0		0^0			0.000	
15^0		15^0			0.259	
30^0		30^0			0.500	
50^0		50^0			0.766	
70^0		70^0			0.940	

Are the results for the two trials the same? If not, to what do you attribute the differences? _____

_____

_____

Plot the Sine of Incident Angle versus the Sine of Refraction angle on a graph. Assuming the index of refraction for air is 1.00, estimate the index of refraction of the cylindrical lens. _____
Attach your graph to your data Sheet.

Reversibility

	Above the Normal	Below the Normal
Average Angle of Refraction (from the table completed in the Law of Refraction activity)	Angle of Refraction	Angle of Refraction

Does the principle of optical reversibility hold for Reflection as well as Refraction? _____

_____

_____

_____

_____

Dispersion

At what angle of refraction do you begin to notice color separation? _____

At what angle of refraction is color separation a maximum? _____

What colors are presented in the refracted ray? _____

Total Internal Reflection

From which surface of the lens does reflection primarily occur? _____

How do the intensities of the reflected and refracted rays vary with the angle of incidence? _____

_____

Are the angles of the reflected ray consistent with the Law of Reflection? _____

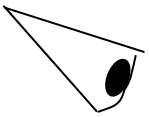
What is the minimum incident angle that the refracted ray is no longer visible? _____

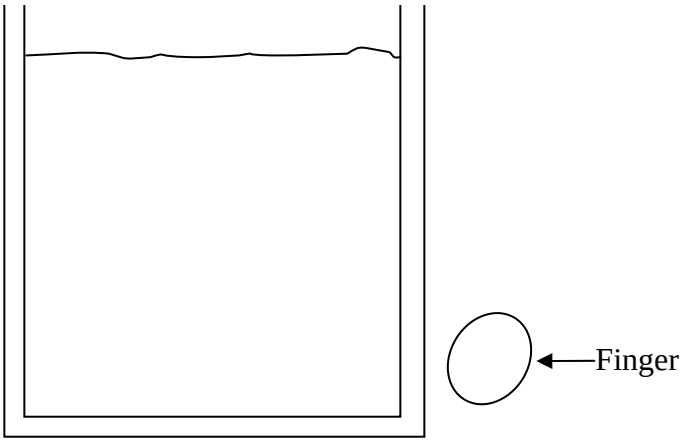
Approximate the index of refraction of the cylindrical lens based on the minimum angle that the refracted ray is no longer visible (Show your Work).

Approximate index of refraction: _____

How does this calculation compare to the index of refraction that was determined during the Law of Refraction activity? _____

Obtain a beaker full of water. While looking through the surface of the water, try to view your finger located on the backside of the beaker. Do not touch the beaker with your finger.





Identify which interface is mainly responsible for the Total Internal Reflection.

_____

Now with a slightly moistened finger, touch the beaker, and describe what you see.

_____

Explain why you can see the ridges of your finger prints but cannot see the valleys. _____