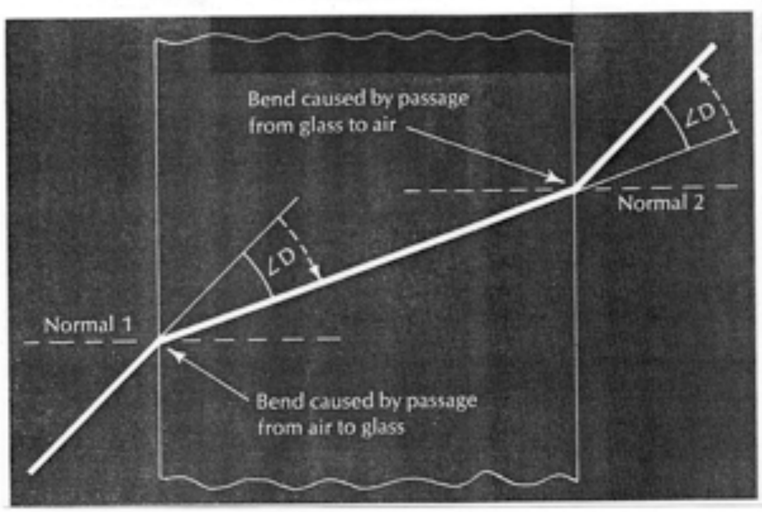
REFRACTION

speed of light in a vacuum = 186,000 miles/second - the ultimate speed limit.
( this is a theoretical value )

Light travels in a straight line.
def: MEDIUM a material that will transmit light.
def:OPTICAL DENSITY refers indirectly to the speed of light in a medium.

def: REFRACTION is the bending of light rays caused by their passing through a surface separating a medium of one OPTICAL DENSITY from a medium of a different optical density.
def: INDEX OF REFRACTION - a number which refers to the optical density of the media that light passes through. It is always greater than 1.000 (1.000 is that perfect vacuum)
The higher the index of refraction, the more light slows down. Ex. glass index is 1.51 - 1.89, water 1.33,diamond 2.42

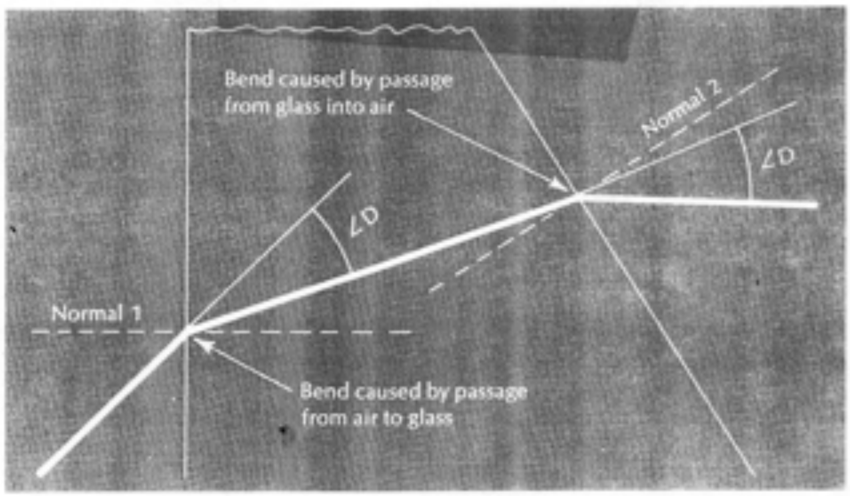



*The ray that enters glass (denser medium) is bent from its original path toward the normal, making Angle D. The ray that enters air (rarer medium) is bent from its original path away from the normal, also making Angle D.*

def: NORMAL - a normal is an imaginary line perpendicular to the surface at the point of incidence.

From low optical density to higher optical density, the light will bend towards the normal. From high optical density to lower optical density, the light will bend away from the normal.

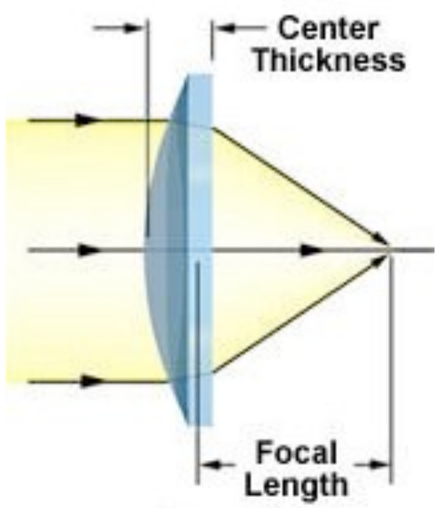
Refraction is uniform and differential. - this means different wavelengths will bend at different rates ( because they have different energies ) but the bending for a given energy, at a given ratio of indices. This differential quality leads to a “rainbow at the edge of sharply focused lights with lenses. This is called chromatic abberation.




*the ray that enters the glass is bent from its original path toward the normal; the ray that enters air is bent away from the normal. But since the normals are not parallel, the paths in air are not parallel.*

3 factors determine the amount of bending that can take place:
1) the ratio between the indices of refraction
2) the angle between the normal at entry and the normal at exit
3) the wavelength of light. Short, energetic waves (UV) bend more than long, less energetic wavelengths.

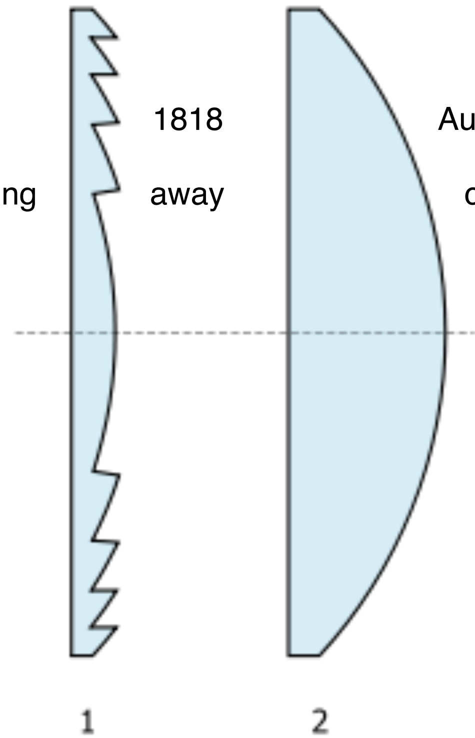
So - refraction in the theatre is the use of lenses.




The principle type of lens is called a “PLANO-CONVEX” lens which describes the two sides of the lens

A STEP LENS takes this functionality and by stepping the plano side away, allows the lens to have less mass (less glass and less weight) and greater bending power.

A FRESNEL LENS 1818 Augustin-Jean Fresnel invented for use in light houses.
Uses scheme of cutting away curved side to reduce mass.




*Comparison of a Fresnel lens (left) and a "conventional" plano-convex lens (right). As can be seen, the Fresnel lens simulates the shape of the conventional lens using individual "facets" (also referred to "ridges" or "grooves") - each of which contain a portion of the lens's overall figure. The grooves of the lenses described on this page face "outwards", away from the focal plane.*

Any lighting instrument using a lens in the theatre is termed a SPOT LIGHT. A lens being the requirement for this designation...

Spot lights in the theatre: Fresnel - uses a Fresnel lens
ERF or LEKO - used at one time a step lens - today they use a lens “train” of Plano-convex lenses.

Notice path of light through lens. Use pc lenses to demonstrate the reversing quality of lenses. Note how light can be focused. Where would the light source be?

REFLECTION

THE LAW OF SPECULAR REFLECTION
The angle of incidence = the angle of reflection. Just like playing pool....

the NORMAL is like in refraction, an imaginary line perpendicular to the surface at the point of incidence.
As the surface is curved, light can be concentrated in FOCAL POINTS - this is a term for both reflection and refraction.

Reflection types:
Specular (from speculum ) = mirror like - image transmission
Mixed = like a varnished floor -
Spread = more diffused - stronger on axis
Diffuse = like white blotter paper

In theatre lighting instruments:
Diffuse reflectors in Olivettes, Scoops and other soft lights
Specular reflectors in Fresnels (spherical )
Beam Projectors ( Parabolic )
Ellipsoidals ( elliptical )

Which type of reflector will be most efficient at concentrating sunlight?

needs for a reflector to perform well:
1). reflector, lens and filament must all be on the same optical axis
( if they aren't a secondary pool of light will be formed and the instrument will lose efficiency )
2) the distance from the reflector to the filament must be equal to the radius of the curvature of the reflector, or the reflector will produce a pool of light larger and lose efficiency...
3) the reflector must have a useful diameter sufficient to encompass the largest cone of light to be used by the spotlight - able to handle both spot and flood...

The Ellipsoidal reflector was invented to increase efficiency. has 2 foci. Newer reflectors use fltted segments to get a smoother field.