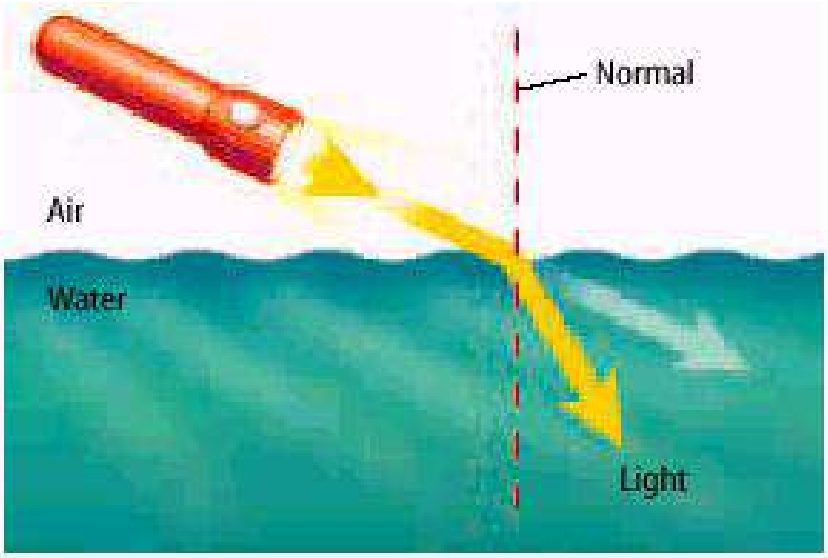
Chapter 14.1 Notes

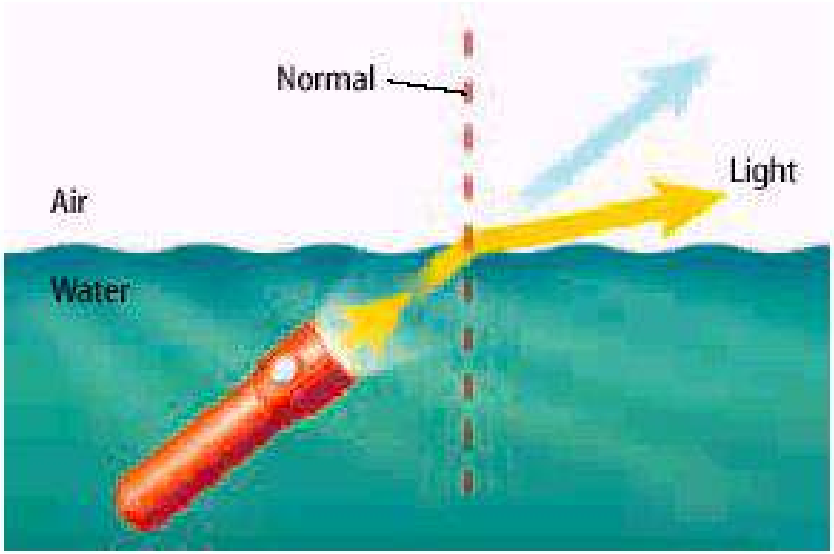
Refraction

Refraction - the *bending* of light due to a change in medium.

(air into water)

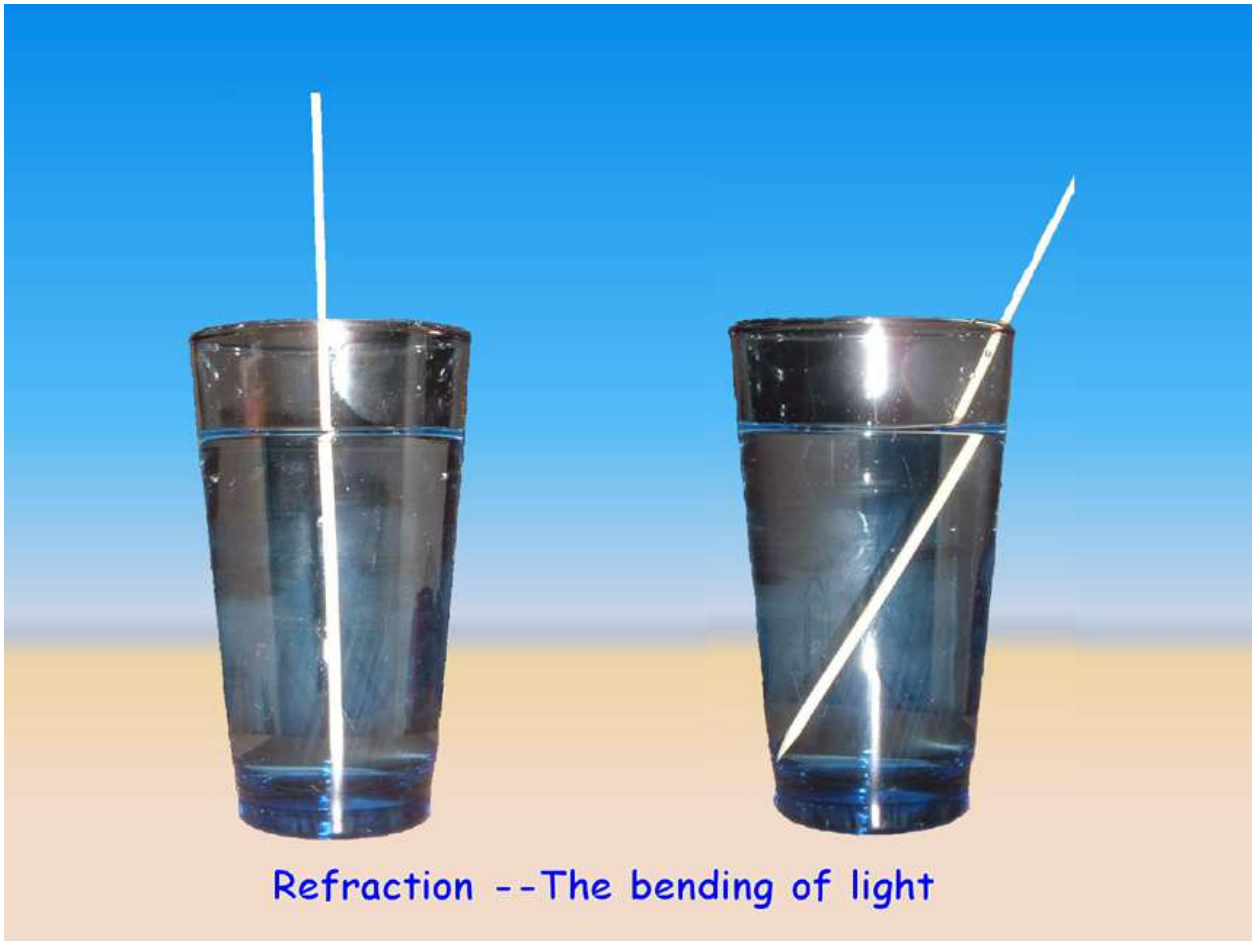
Light travels slower in water than in air.





Refraction

- The bending of light as it travels from one medium to another is called refraction.



The girl sees the boy's foot closer to the surface than it actually is.

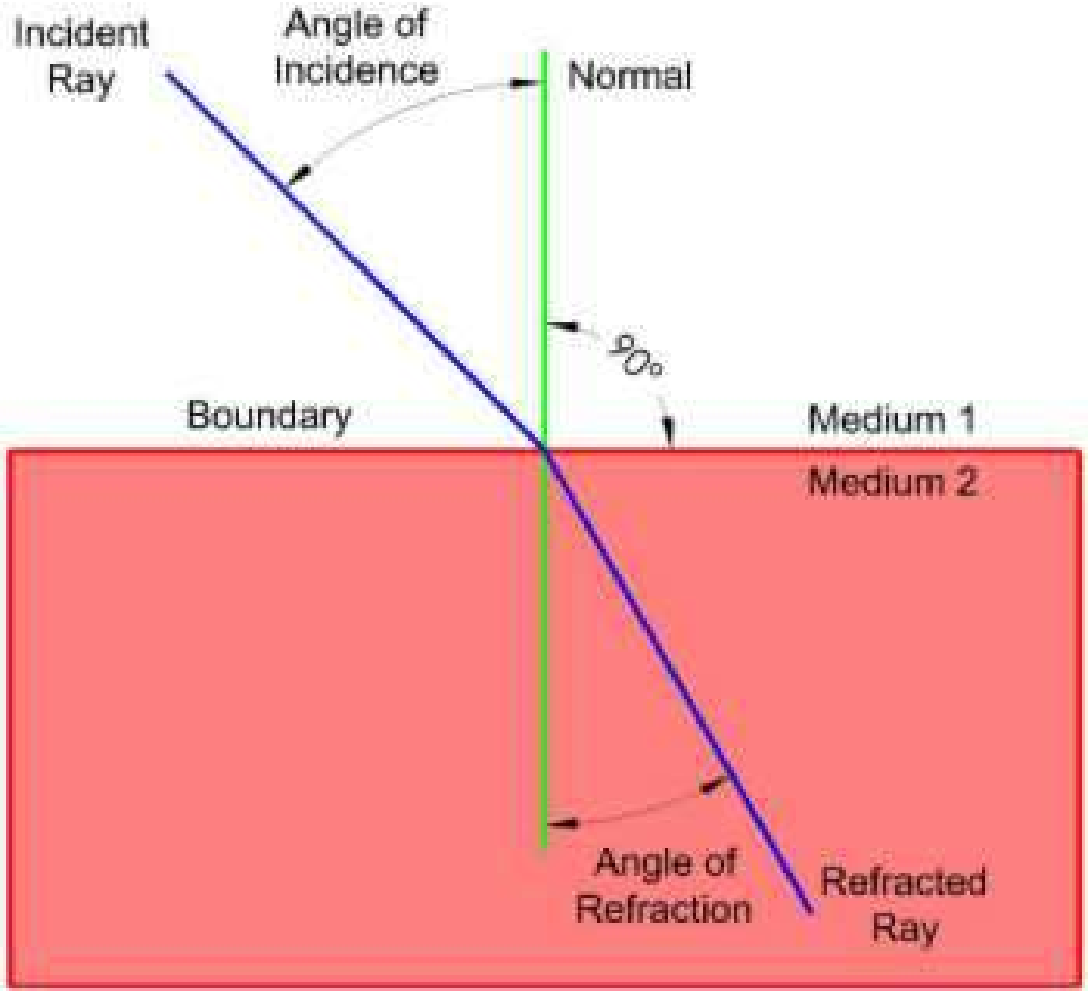
The boy is looking straight down and not at an angle. There is no refraction for him.


Light ray travelling on the normal
passes through different medium
without bending

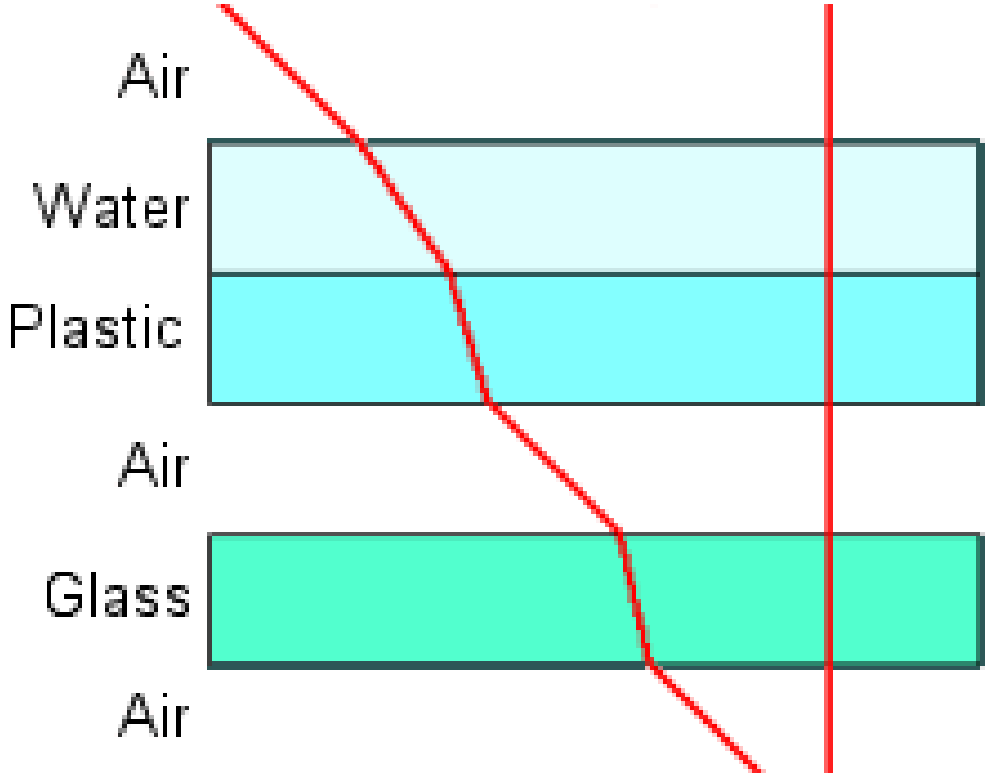
Refraction Demos

- Egg
- Refraction goggles
- Solar system ball
- Beaker Bead
- Wax demo
- Kaleidoscope
- Round plastic

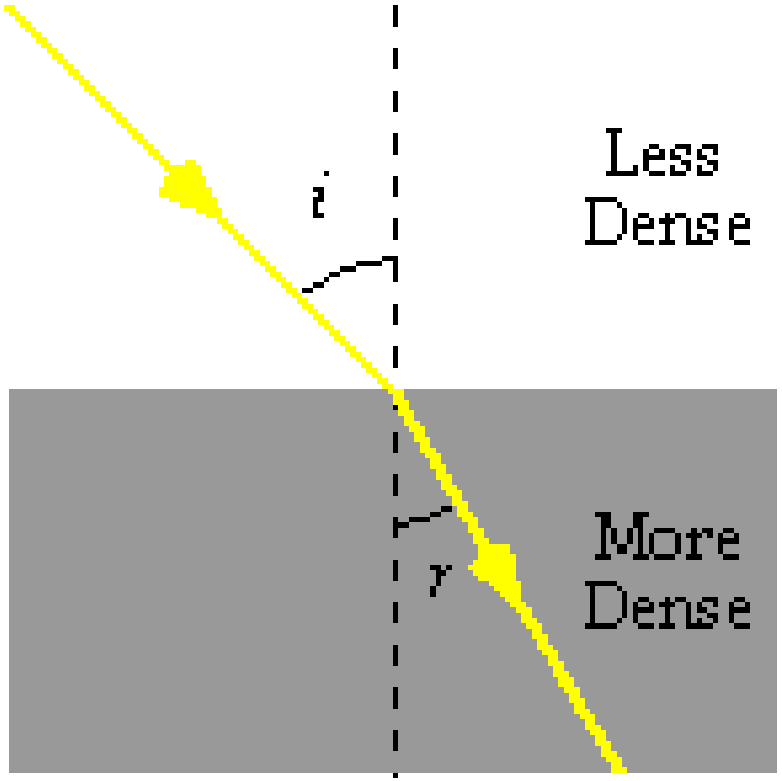
- The angle between the refracted ray and the normal is called the angle of refraction. The angle between the incidence ray and normal is called the angle of incidence.



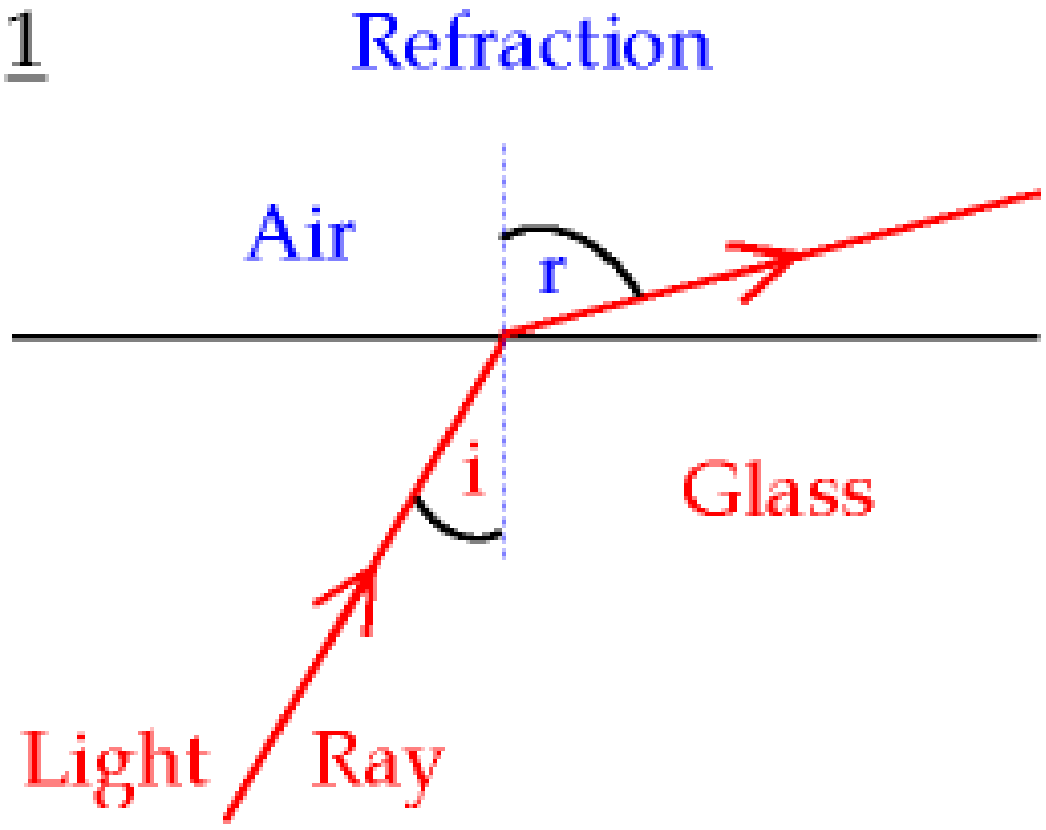
- Glass, water, ice, diamonds, and quartz are all examples of transparent media through which light can pass. The speed of light in each of these materials is different.



- When light moves from a material in which its speed is higher to a material in which its speed is lower, such as from air to glass, the ray is bent toward the normal.



- If the ray moves from a material in which its speed is lower to one in which its speed is higher, the ray is bent away from the normal.

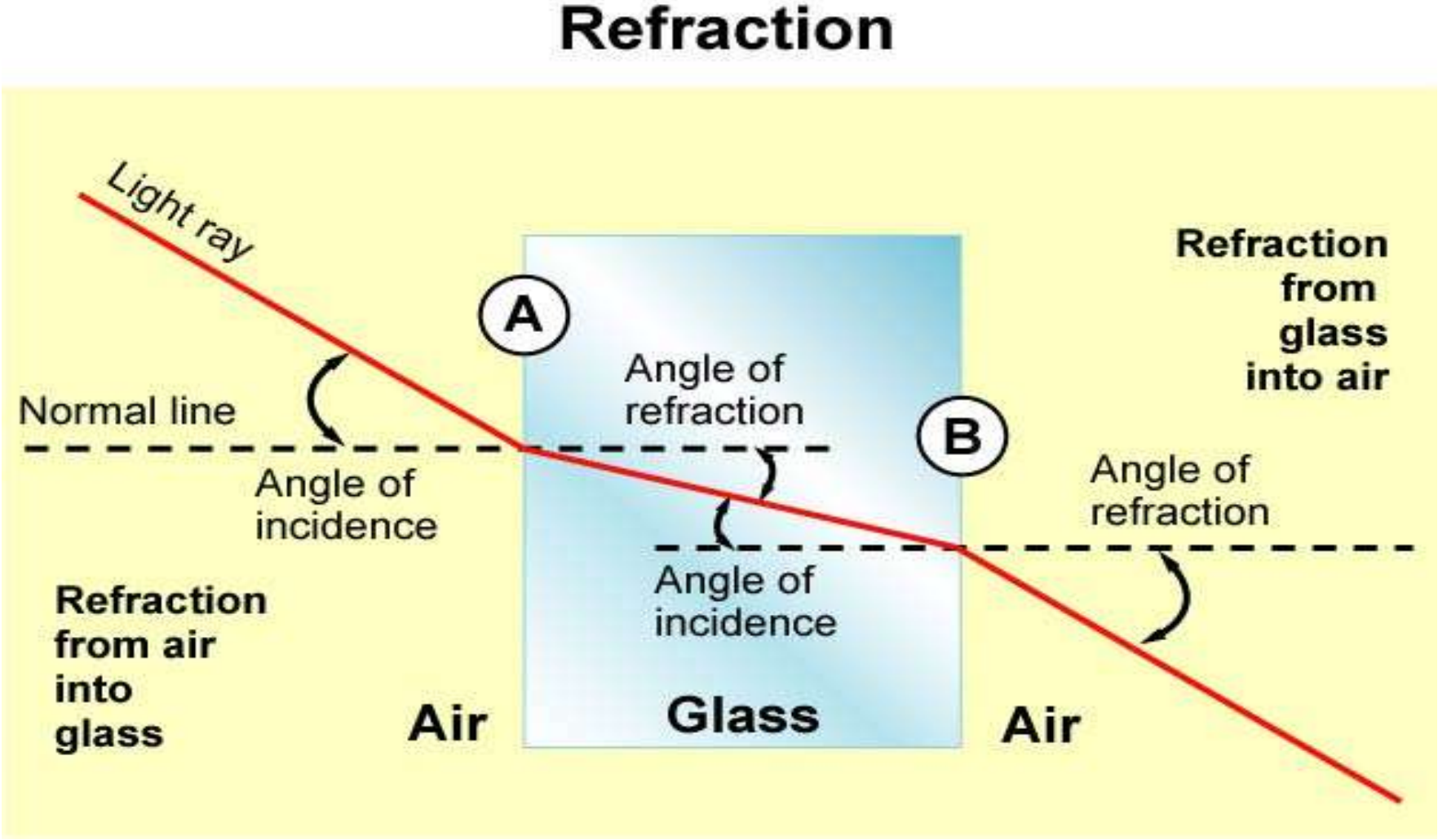


- The index of refraction for a substance is the ratio of the speed of light in a vacuum to the speed of light in that substance.
- Index of Refraction = Speed of light / Speed of light in medium
- Speed of light = 3×10^8 m/s
- Index of Refraction for air = 1

If the speed of light in a diamond is 1.42×10^8, what is the index of refraction?

Snell's Law

- Index of refraction$_I$ ($\sin\theta_I$) = Index of refraction$_R$ ($\sin\theta_R$)



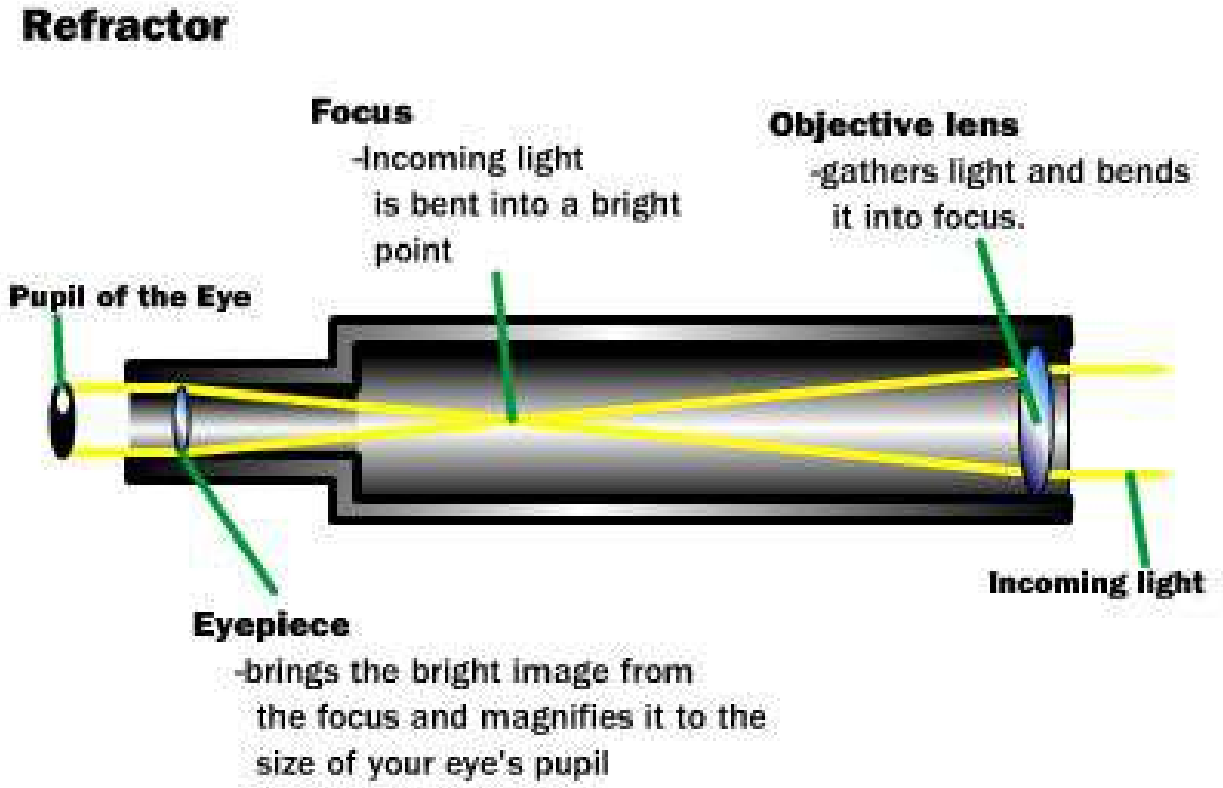
If a light ray leaves the air (that has an index of refraction of 1) enters glass at an angle of 30 degrees and exits at an angle of 26 degrees, what is the index of refraction of the glass?

14-2 Notes

Lenses

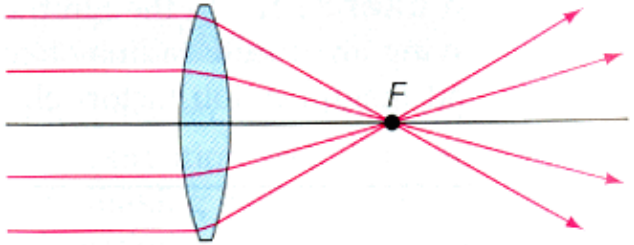
Lenses

- Like mirrors, lenses form images, but lenses do so by refraction rather than reflection.
- Examples include, magnifying glasses, contact lenses, microscope, telescope.

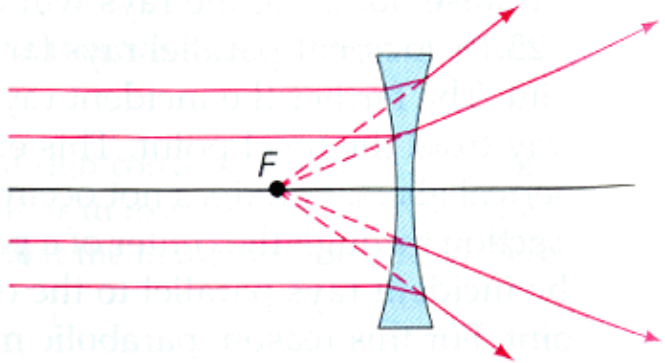


2 Types of Lenses

- Converging lenses – Thicker at the middle and thinner at edges
- Diverging lenses – Thinner at the middle and thicker at the edges



Converging lens

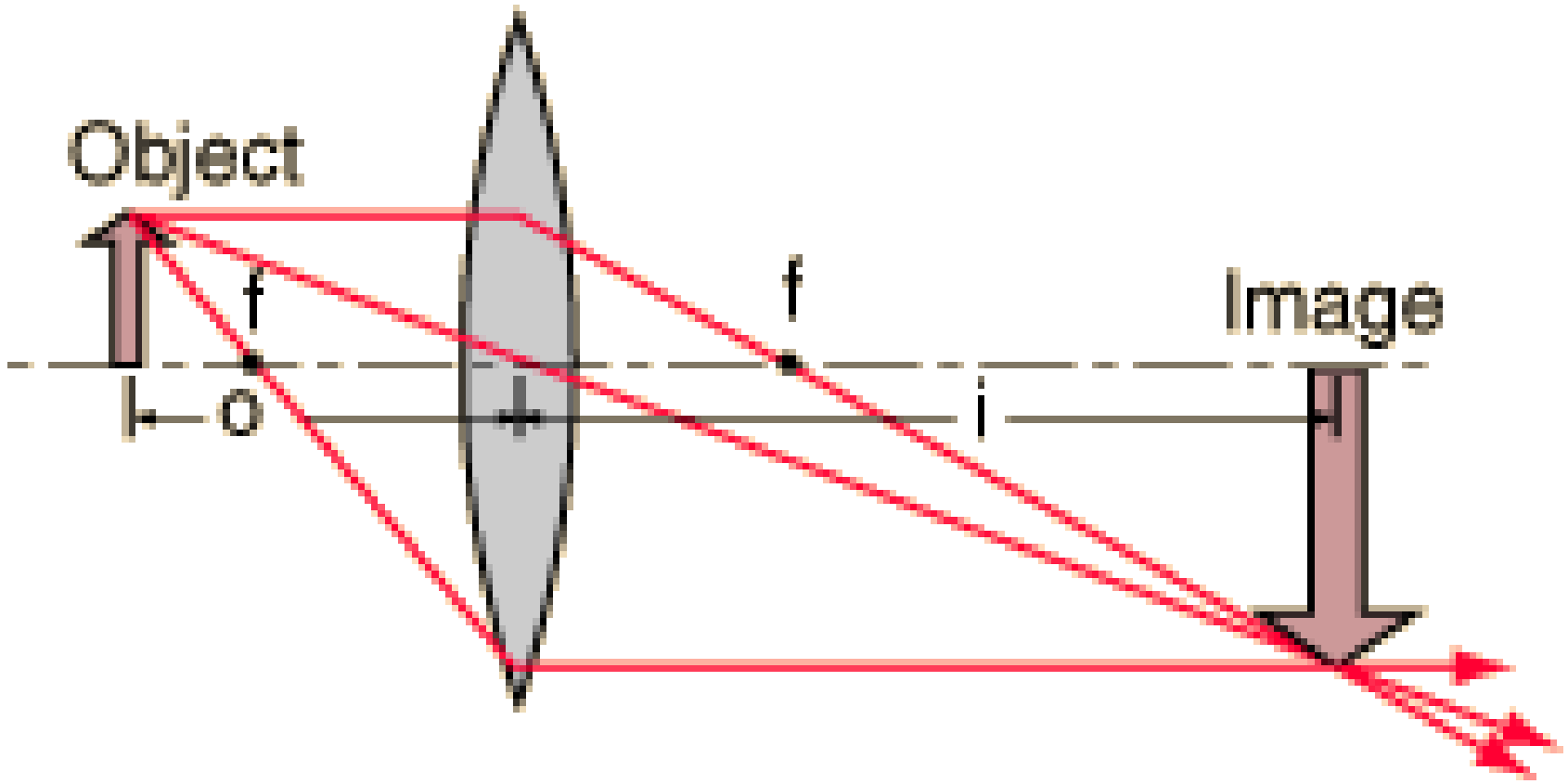


Diverging lens

Demos

- Concave and convex lenses
- Magnifying glasses
- Adjustable glasses
- Batman light
- Phone projector
- Flashlight

Draw Image Created by Converging Lenses



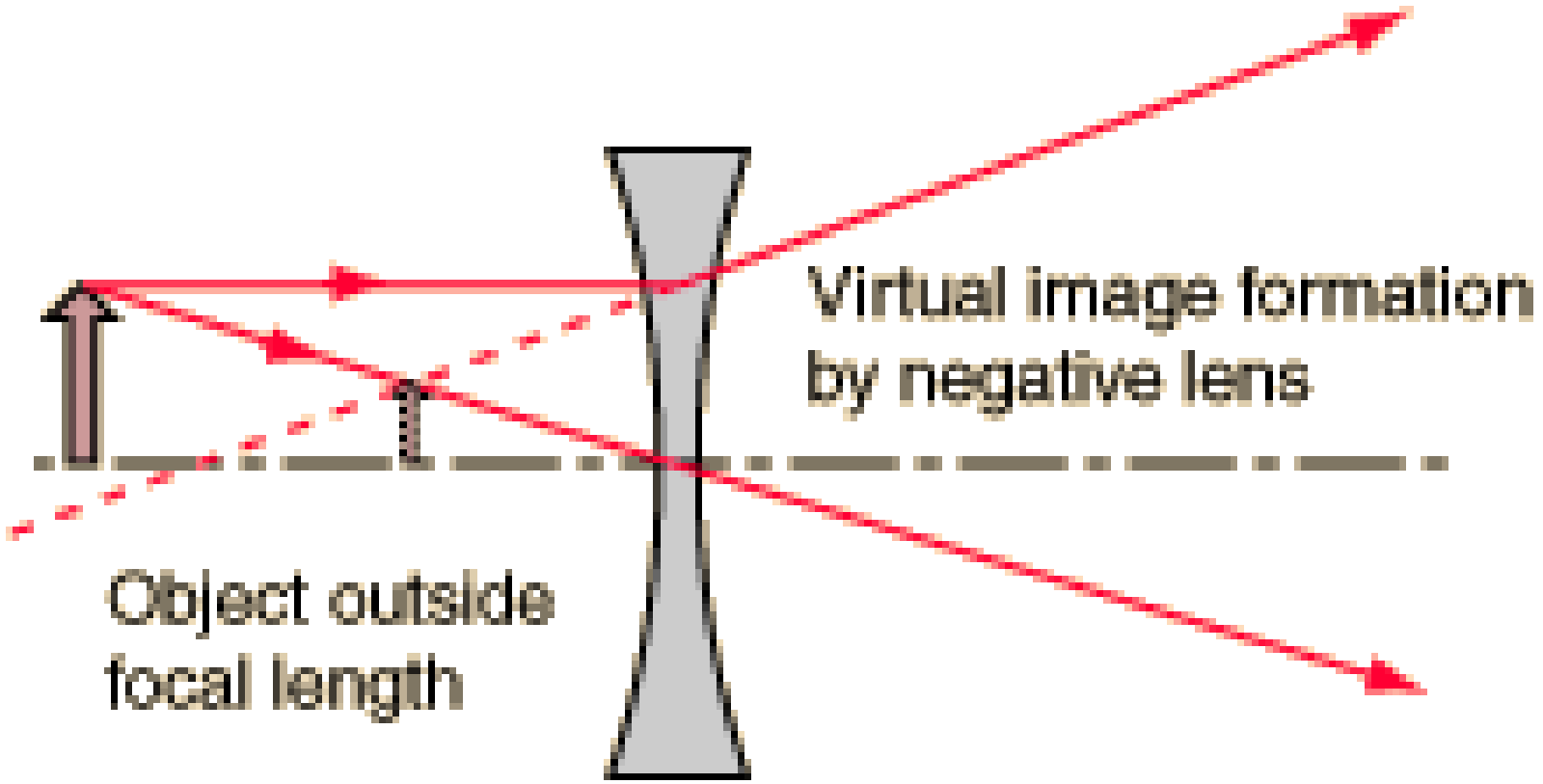
Examples of Converging

- Magnifying Glasses
- Microscope – Work by using several converging lenses to focus light
- Far sightedness (Glasses)

Examples of Diverging

- Telescopes – Work by using several Diverging lenses to focus light
- Near sightedness (Glasses)

Draw Image Created by Diverging Lenses



- Real image – an image formed when rays of light actually intersect at a single point.
- Real image is a clear crisp image that is formed.
- Image location can be predicted with the mirror equation
- $1 / p + 1 / q = 1 / f$
- $1 / p + 1 / q = 2 / R$
- p = object distance; q = image distance
- f = focal length; R = Radius

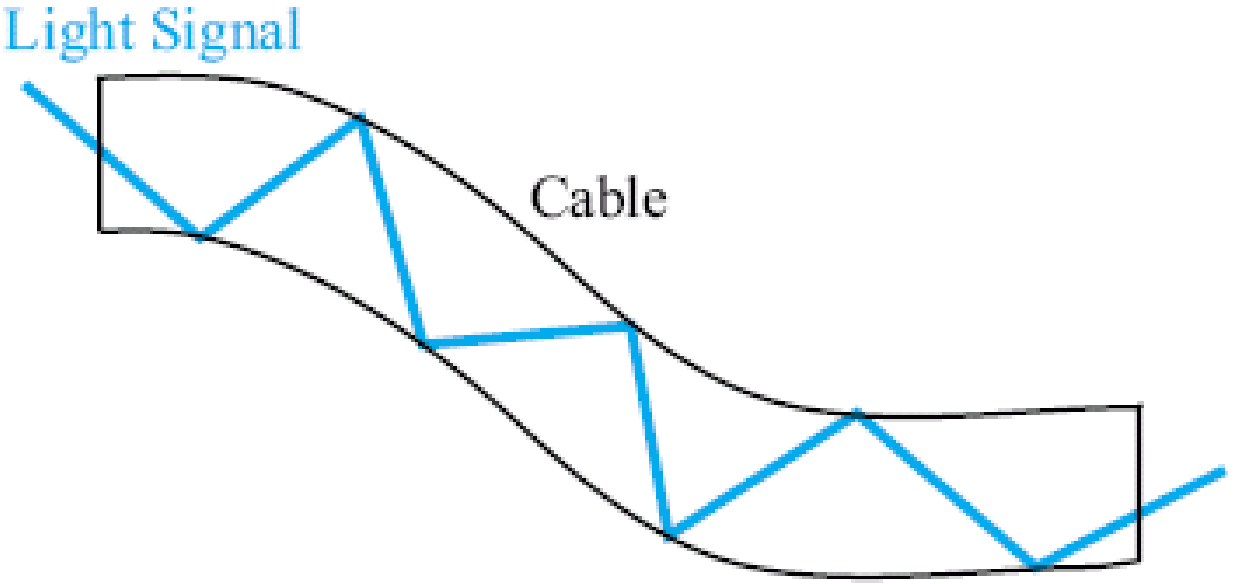
- Unlike flat mirrors, the images formed are not the same size as the original image.
- How big or small they appear can be calculated:
- $M = h' / h$
- $M = q / p$
- M = Magnification; h’ = image height
- h = object height; q = image distance
- p = object distance

- If M is + then the image is Upright and Virtual.
- If M is – then the image is Inverted and Real

- An object is placed at 30 cm in front of a converging lens. The focal length of the lens is 10 cm. Find the image distance and the Magnification. Is it real or virtual?

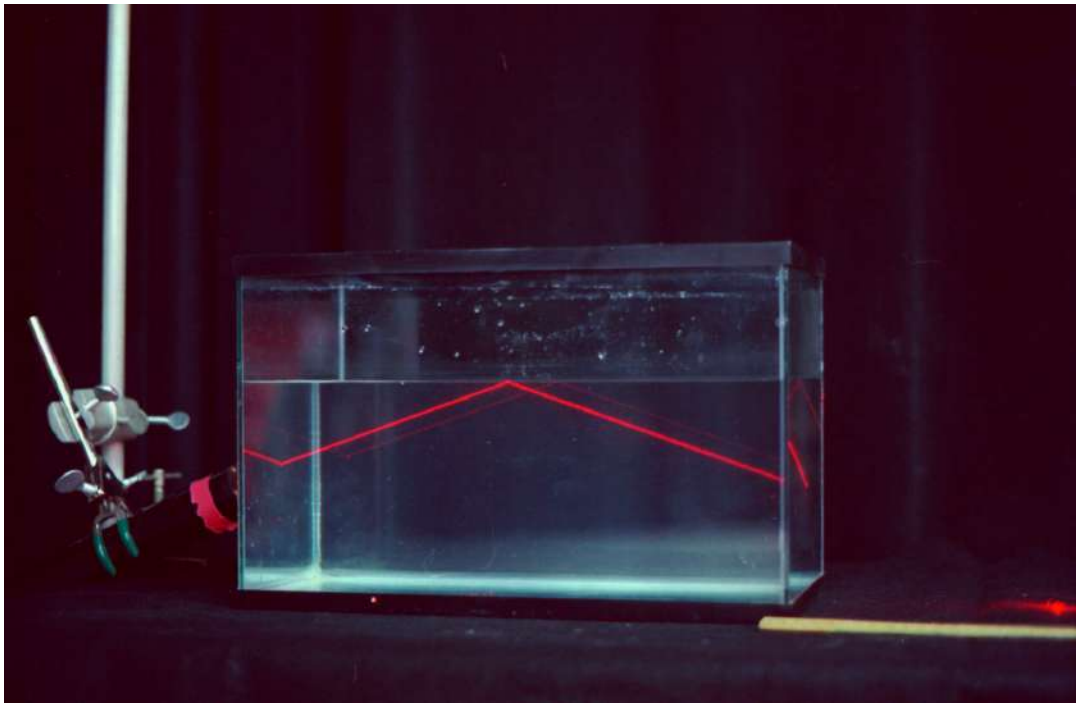
Total Internal Reflection

- Total Internal Reflection can occur when light moves along a path from a medium with a higher index of refraction to one with a lower index of refraction. (Demo)



Critical Angle

- At some particular angle of incidence, called the critical angle, the refracted ray moves parallel to the boundary, making the angle of refraction equal to a 90 degree angle.



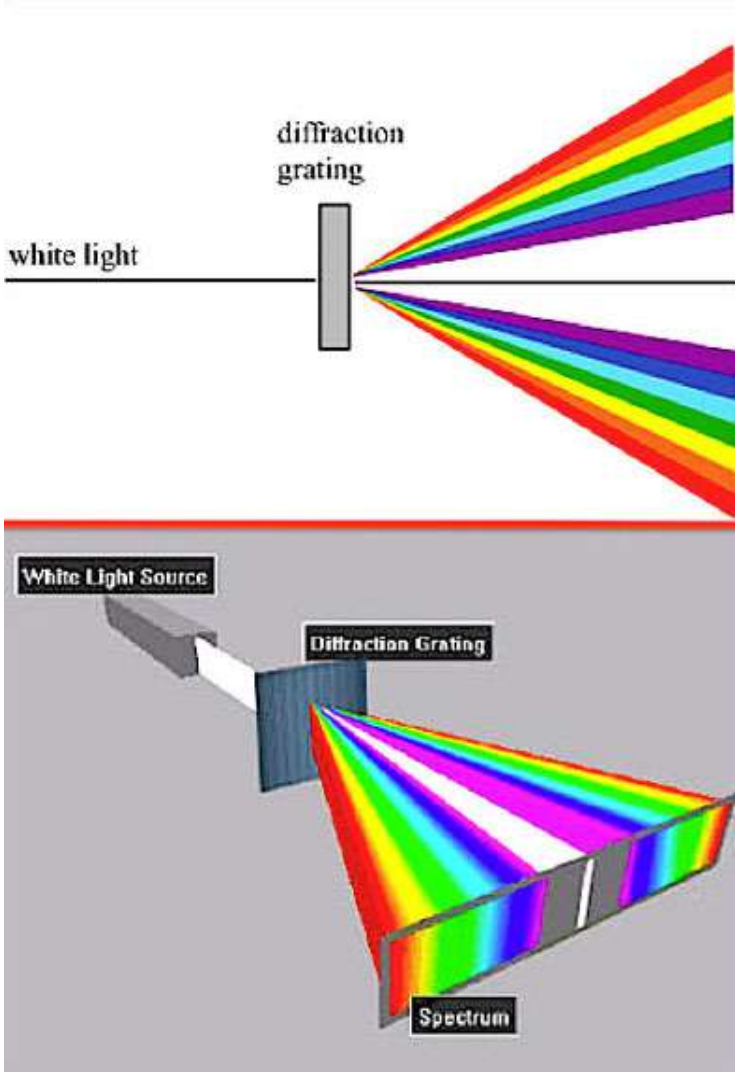
Critical Angle Equation

- Sine of Critical Angle = index of refraction of 2^{nd} medium / index of refraction of 1^{st} medium
- $\sin\theta_c$ = Index of Refract $_1$ / Index of Refract $_2$

Find the critical angle for a water-air boundary if the index of refraction of water is 1.5 and the index of refraction for air is 1.00.

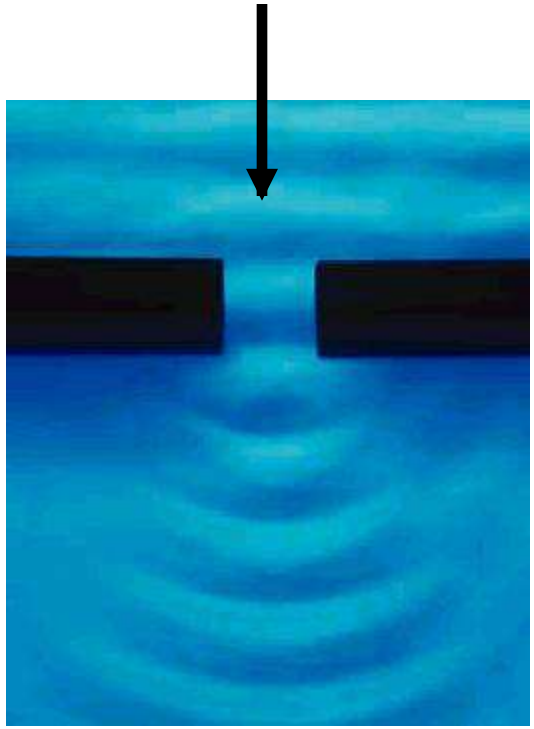
Diffraction

- The process by which a beam of light is spread out as a result of passing through a narrow opening.
- (Water Prism)



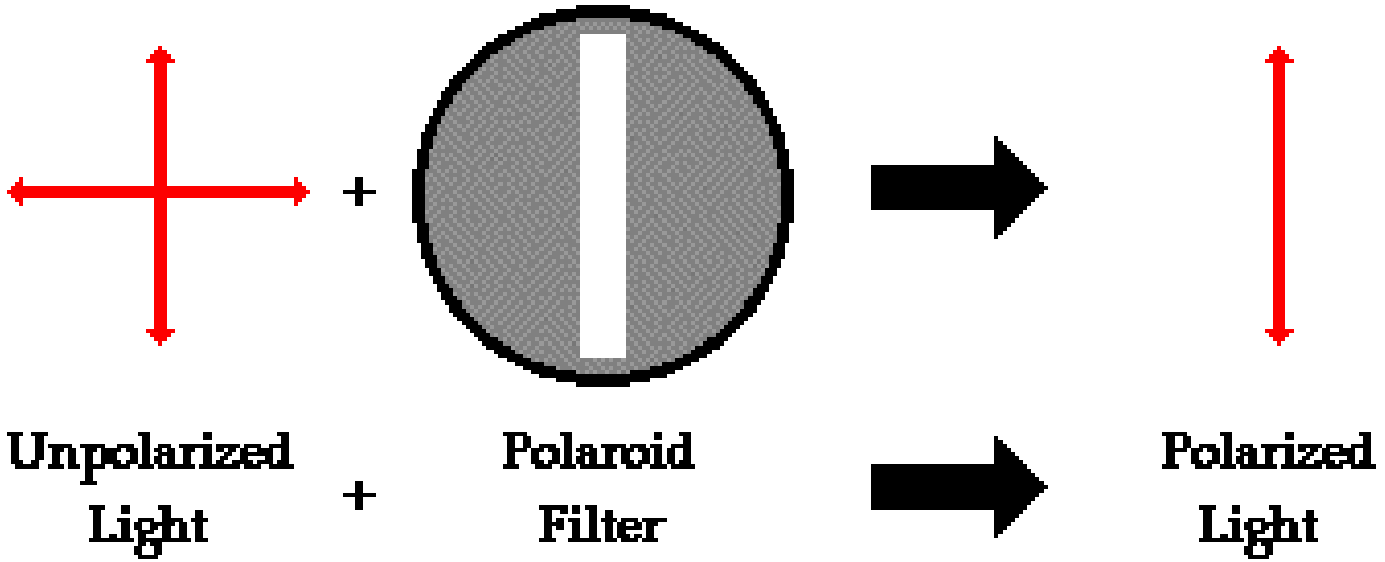
Diffraction - the bending of a wave *around* an object.

1) Water waves bending around islands

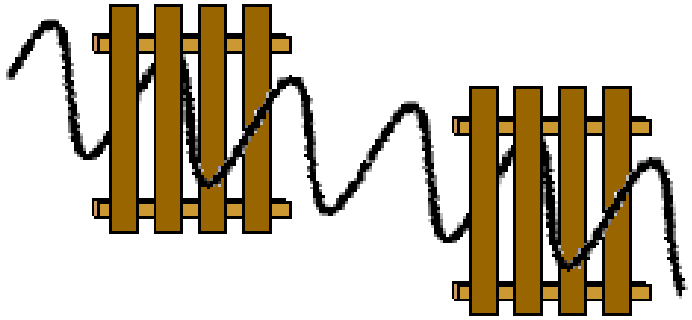


2) Water waves passing through a slit and spreading out

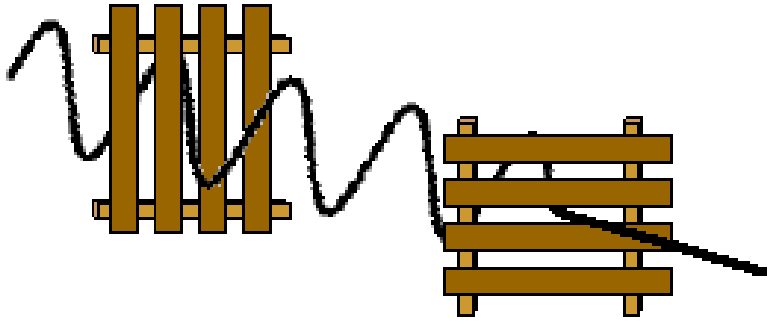
Polarization – *filtering* of light into a single plane



The Picket Fence Analogy



When the pickets of both fences are aligned in the vertical direction, a vertical vibration can make it through both fences.



When the pickets of the second fence are horizontal, vertical vibrations which make it through the first fence will be blocked.

Teacher

Teacher seen through two Polaroids

Axes aligned parallel to each other

Teacher seen through two Polaroids

Axes aligned perpendicular to each other

Polarized Lenses (demo and video)