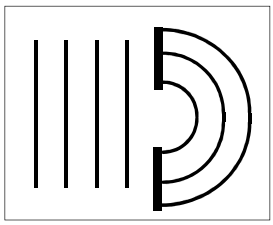
Diffraction and Polarization

and scattering, too.

What is Diffraction?

- **The spreading of waves around a barrier.**

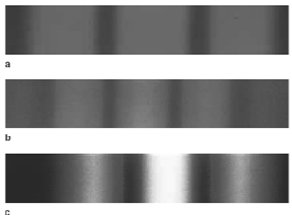


Single - Slit Diffraction

- **Creates a broad central bright band, followed by dark and light bands**
- **Creates dark bands because of destructive interference**
- **Creates light bands because of constructive interference**
- **Remember - destructive interference occurs when two waves are <u>one-half</u> a wavelength out of phase**

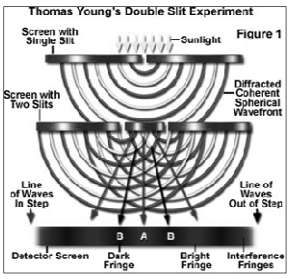
Using Diffraction to Measure the Wavelength of Light

- Direct relationship between the distance between bands and the wavelength of the light source. (Larger wavelength = larger bands)
  - **Red Light**
  - **Blue Light**
  - **White Light**



Double Slit Interference

- **The mutual effect of two beams of light that results in a loss of intensity at certain regions and reinforcement of intensity at other regions. When projected on a screen, these regions can be seen as a series of dark and light regions, respectfully.**



http://micro.magnet.fsu.edu/primer/java/interference/doubleslit/

Diffraction Gratings

- **A thin film having a series of slits a few hundred nanometers apart**
- **Increases the effect of the interference pattern, making it easier to observe**
- **Used to determine the wavelength of light and the content of stars as well as 3D imaging.**

Multi-Slit Interference

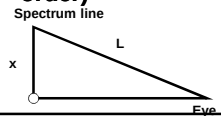
- The smaller the distance between slits, the larger the distance between bands

- The larger the wavelength, the larger the amount of diffraction.

Finding the Wavelength

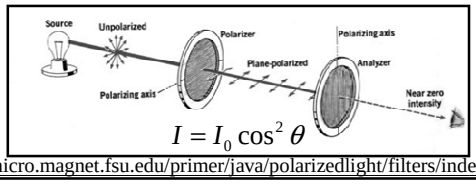
- The amount of diffraction of light depends on the distance between the slits and the wavelength of the light shining through it.
- d is the distance between the slits on grating
- x is the distance between the light source and line or central band and line
- L is the distance viewer is from the light or from light to screen
- n is # of the image set (nth order)

$$\lambda = \frac{dx}{nL} = \frac{d \sin \theta_n}{n}$$



Polarization

- The confining of wave movement to one plane along the line of propagation.
- Property of <u>only</u> transverse waves



$$I = I_0 \cos^2 \theta$$

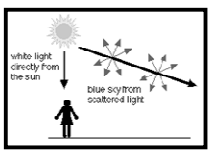
http://micro.magnet.fsu.edu/primer/java/polarizedlight/filters/index.html

How is Light Polarized?

- Selective absorption (dichroism)
  - Polarized sunglasses use this material to filter out glare.
- Reflection
  - When light strikes a surface, the reflected waves are polarized to match the angle of that surface.
- Refraction
  - Ex: Calcite

Why is the sky blue?

- The blue color of the sky is due to a scattering of the light from the sun called <u>Rayleigh scattering</u>.
- This causes the light to scatter when it passes through particles that have a diameter one-tenth that of the wavelength (color) of the light.
- This scattering is most efficient at shorter wavelengths (the blue end of the spectrum).



What about sunsets?

- Sunsets are reddened because the light pass through a greater thickness of air than when it is overhead. Since short wavelengths are more efficiently scattered, more of these wavelengths (blue) are scattered out of the beam of sunlight before it reaches you.
- As light collides with more particles, the shorter wavelengths are scattered leaving the beam of light to appear red.