PROPERTIES OF WAVES

Reflection
- When waves encounter a barrier, some reflection occurs.

- Echo is reflection of sound waves; image is reflection of light waves.

- The Law of Reflection states that the angle of incidence is equal to the angle of reflection.

Refraction
- When light waves encounter a transparent medium, some is reflected and some is transmitted.

- The transmitted light changes speed and direction, and bends as a result.

- Bending of light due to a change in speed is called refraction.
**INDEX OF REFRACTION**

- *Index of refraction* is the *ratio* of speeds of light in two *media*.

\[
\text{Index of refraction} = \frac{\text{velocity of light in vacuum}}{\text{velocity of light in medium}}
\]

\[
n = \frac{c}{v}
\]

- Speed of light in vacuum has been measured to be \(3.0 \times 10^8\) m/s.
- Since light travels fastest in vacuum, the *index of refraction* is always *greater than 1*.

**Examples:**
1. Ice has an index of refraction of 1.305. What is the velocity of light in ice?

\[
n = \\
c = \\
v = ???
\]

2. Water has an index of refraction of 1.33. What is the speed of light in water?

\[
n = \\
c = \\
v =
\]

3. The speed of light in glass is \(2.0 \times 10^8\) m/s. What is the index of refraction of glass?

\[
n = \\
c = \\
v =
\]
**DISPERSION / DIFRACTION**

**Dispersion**

- When *white light* is passed through a glass *prism*, it is *dispersed* into a spectrum of *colors*.

![Dispersion Diagram]

- As *each wavelength* of visible light enters the prism, it *refracts differently*.
- The *longest* wavelength (*red*) refracts the *least*, and the *shortest* wavelength (*violet*) refracts the *most*.

**Diffraction**

- *Bending* of waves around *obstacles* is called *diffraction*.

- Waves passing through 1 or 2 slits near one another create a unique pattern due to diffraction

- *Sound* can be heard around corners, and *light* can be seen through openings due to *diffraction*. 
INTERFERENCE

- When two waves occupy the same space, *interference* occurs.

- *Constructive* interference occurs when the waves are *in phase*, i.e. their crests and troughs are aligned similarly. As a result, *reinforcement* of the waves occurs.

- *Destructive* interference occurs when the waves are *out of phase*, i.e. their crests and troughs are aligned opposite of each other. As a result, *cancellation* of the waves occurs.
Polarization

- Refraction and interference are evidence that light is wavelike in nature.

- Polarization of light is evidence that light is a transverse wave.

- A transverse wave can be generated along different planes. Such wave is called unpolarized).

- When unpolarized light is passed through a Polarizer, only the waves in the direction of the filter can pass through (c).

- When two polarizing filters are aligned, the amount of light transmitted through depends upon their alignment.
SIMPLE LENSES

- A practical effect of *refraction* occurs in *lenses*.
- Two types of lenses:

<table>
<thead>
<tr>
<th>Convex or Converging</th>
<th>Concave or Diverging</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <em>thicker</em> at <em>center</em> than edges</td>
<td>• <em>thinner</em> at <em>center</em> than edges</td>
</tr>
<tr>
<td>• refracted rays <em>converge</em> at a point</td>
<td>• refracted rays <em>diverge</em> from a point</td>
</tr>
<tr>
<td>• light waves slow down more through the center of lens</td>
<td>• light waves slow down more at the edges</td>
</tr>
</tbody>
</table>

- Convex or converging lenses are thicker at the center than at the edges, and the refracted rays converge at a point. Light waves slow down more through the center of the lens.
- Concave or diverging lenses are thinner at the center than at the edges, and the refracted rays diverge from a point. Light waves slow down more at the edges.
VISION CORRECTION

- **Nearsightedness** occurs when image is formed in *front* of the retina. This condition is corrected by wearing glasses with *diverging* lenses.

- **Farsightedness** occurs when image is formed *behind* the retina. This condition is corrected by wearing glasses with *converging* lenses.
• **Colors** of most objects are due to *selective reflection* and *absorption* of light by a material.

• The *red glass* appears red because it *transmits* the red component present in white light, and *absorbing all other colors*.

• When light rays are *reflected* from the top and bottom surfaces of a *thin film* (soap bubble, oil film, etc.), *constructive* and *destructive interference* occurs. As a result, a variety of color is visible to the observer.