Critical Angle and Total Internal Reflection

When light passes from more dense to less dense media, the light bends away from the normal up to 90 degrees and then is totally internally reflected.

Example

- Light passes from water up to the air. Using Snell's Law (n1sin1 = n2sin2) determine the angle of refraction in the air.
- 1.33sin44 = 1sin(angle) => 67 degrees
- 1.33sin45 = 1sin(angle) => 70 degrees
- 1.33sin46 = 1sin(angle) => 73 degrees
- 1.33sin47 = 1sin(angle) => 76 degrees
- 1.33sin48 = 1sin(angle) => 81 degrees
- 1.33sin49 = 1sin(angle) => 90 degrees

Critical Angle

- When light passes from dense material to less dense material, the light bends away from the normal. At a particular incident angle the angle of refraction will be 90 degrees and the refracted ray will skim the surface. The incident angle at which this occurs is called the critical angle.
- Sin(critical angle) = n2/n1
- Critical angle = arcsin(n2/n1)

Examples

- Refraction from water to air
- Critical angle = arcsin(1/1.33) = 49 degrees

- Refraction from diamond to air
- Critical angle = arcsin(1/2.42) = 24 degrees

Total Internal Reflection

- For angles greater than the critical angle, there is NO REFRACTED LIGHT. ALL OF THE LIGHT IS REFLECTED. This is called total internal reflection.

Applications of total internal reflection

- Fiber optics using glass or plastic

  useful in telecommunications for telephone calls, video signals, and computer data.

  useful in medical diagnostics: colonscopy, endoscopy, bronchoscopy

Group Activity

- Determine the Critical Angle for the following refractions:
  - Crown glass to air
  - Corn oil to air
  - Zircon to air
  - Crown glass to water
  - Corn oil to water
  - Zircon to water