

Reflection and Refraction

Reflection

Reflection is the _____.

How much reflection depends upon how _____ the surface is.

If the surface is **smooth** and **flat**, the light will bounce off it at _____.

If the surface is **rough**, the light _____.

There are special geometries governing reflection.

Refraction

Refraction is the _____ when it enters a new medium. This is caused by a _____ as it passes from one medium (incident medium) to another (refracted medium).

When wave changes media its frequency _____. But because speed has changed, the _____.

Light travels at the speed of light (c), but when it travels thru media which are transparent, the "speed" of light changes.

The equation used to relate the speed of light in a certain substance compared to the refraction of the light as it entered is:

The _____ (n) is a ratio comparing the speed of light in a vacuum (c) to the speed of light in a substance (v) the light moves through.

Example 1: Light moves through water at $2.25 \times 10^8 \text{ m/s}$, determine water's index of refraction.

Example 2: Quartz has an index of refraction of 1.54, determine the velocity of light in quartz.

* The lowest index of refraction is for a vacuum $n = 1.000$

* The next lowest is air $n = 1.0003$

* The maximum (common things) diamond $n = 2.42$

Snell's Law

Willebrord Snell was a Dutch research physicist who measured the angles of light as they entered different media. He found a relation between the angle of incidence and the angle of refraction.

Example 3: A ray of light starts in air and has an angle of incidence of 30° to some cooking oil.

a) If an angle of refraction of 24.2° is produced in the oil, what is the index of refraction of the oil?

b) What is the speed of light in cooking oil?

When light travels:

- from a **less dense to a more dense** medium, the light _____, and the refracted ray is bent _____ the normal. (going from lower n value to higher n value)

- from a **more dense to a less dense** medium, the light _____, and the refracted ray is bent _____ the normal. (going from higher n value to lower n value)

Example 4: A ray of light travels from air into water. If the angle of incidence was 30° what will be the angle of refraction in the water?

Critical Angle

When light travels from a higher index of refraction to a lower one ($n_i > n_r$) and if the incident angle (θ_i) is big enough then the refracted angle (θ_r) will be 90° . We call this incident angle the critical angle θ_c .

Example 5: Find the critical angle for light traveling from water to air

Total Internal Reflection

For any angle of incidence bigger than the critical angle **no light** enters the new medium. All light is reflected according to the law of reflection. We say that total internal reflection has occurred.