

Reflection and Refraction (of Light Waves)

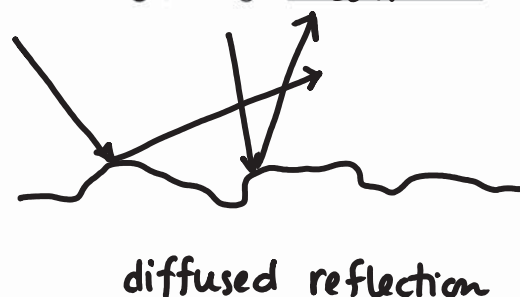
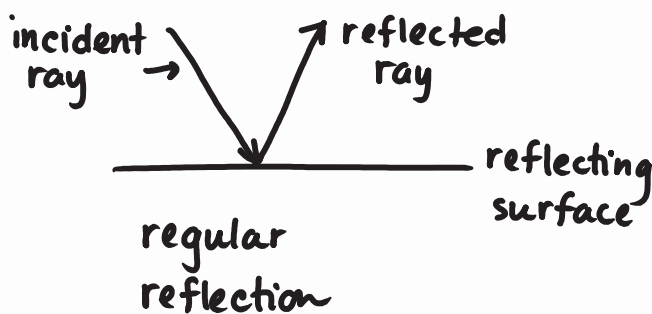
Reflection

Reflection is the rebouncing of a wave off of a boundary.

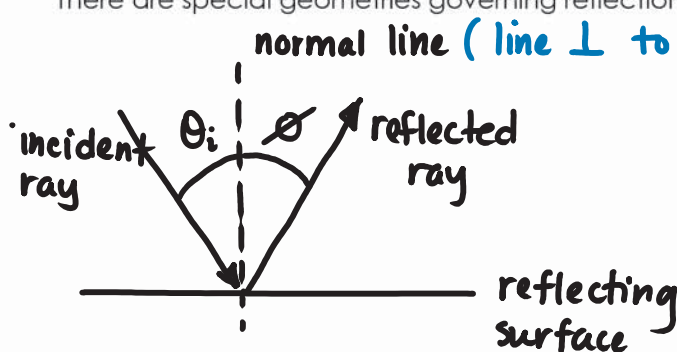
How much reflection depends upon how even the surface is.

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

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



There are special geometries governing reflection.



θ_i = angle of incidence

ϕ = angle of reflection
("phi")

$\theta_i = \phi$ Law of Reflection

Refraction

Refraction is the bending of a wave when it enters a new medium. This is caused by a change in the wave speed as it passes from one medium (incident medium) to another (refracted medium).

When a wave changes media its frequency remains constant. But because the speed has changed, the wavelength has changed.

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:

$$n_{\text{substance}} = \frac{c}{v_{\text{substance}}}$$

index of refraction \rightarrow $n_{\text{substance}}$ \leftarrow speed of light in a vacuum ($3.0 \times 10^8 \text{ m/s}$)

$v_{\text{substance}}$ \leftarrow speed of light going through a new substance (or medium)

The index of refraction (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.

* 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 $n = 2.42$

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

$$n_{\text{water}} = \frac{c}{v_{\text{water}}} = \frac{3.0 \times 10^8}{2.25 \times 10^8} = 1.33$$

★ No units

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

$$n_{\text{quartz}} = \frac{c}{v_{\text{quartz}}}$$

$$1.54 = \frac{3.0 \times 10^8}{v_{\text{quartz}}}$$

$$v_{\text{quartz}} = \frac{3.0 \times 10^8}{1.54} = 1.95 \times 10^8 \text{ m/s}$$

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