

Grade 10

Optics

Nature of Light

Light is a Wave.

Wave /

Undulatory Theory

In the 1670s:
light travels
through 'ether'
and reflection
can be
explained via
waves



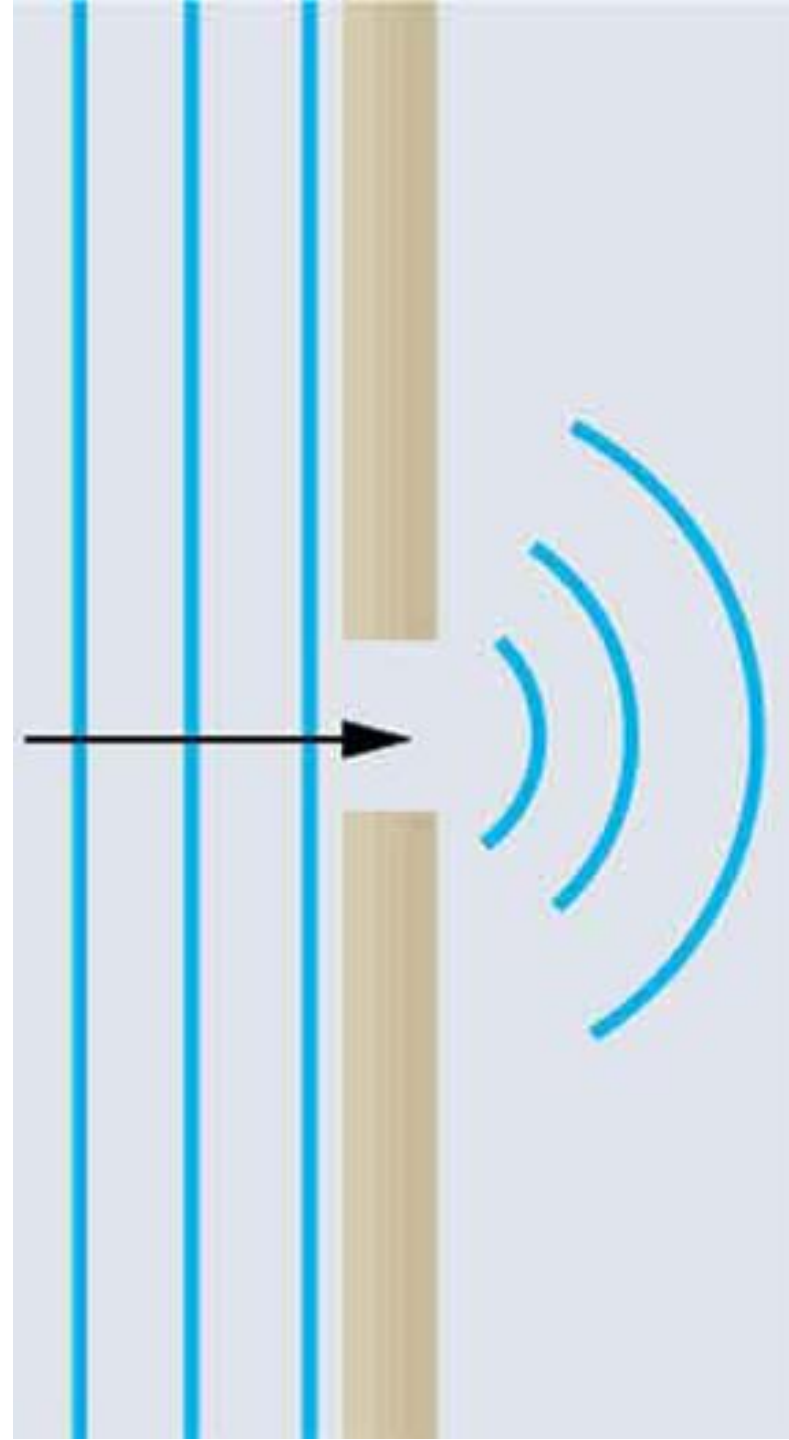
**Christian
Huygens**

Huygen's Principle every point on a wavefront is a source of wavelets. These wavelets spread out in the forward direction, at the same speed as the source wave.

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Huygen's Principle

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1801:
conducted the
**Double-Slit
Experiment**



**Thomas
Young**

1873:
predicted the
EM waves &
their speed



**James Clerk
Maxwell**

1887:
proved
Light IS an
EM Wave.



**Heinrich
Hertz**

Light is a Particle.

Corpuscular / Emission
Theory

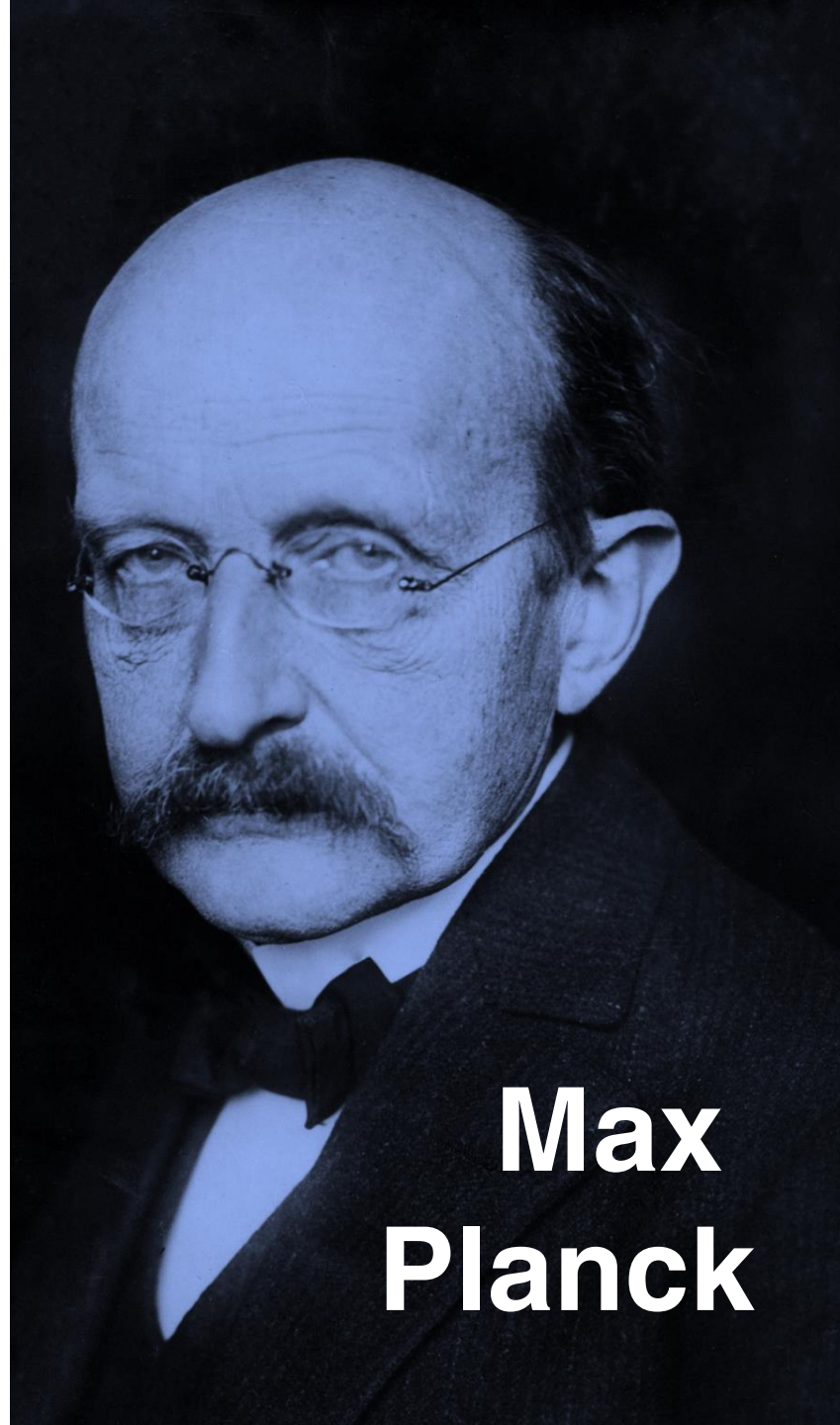
In the 1600s:

Light is made
up of particles
called

corpuscles

Planck's Constant (h)

Energy in
photons only
exists in
multiples of
 6.626×10^{-34} .



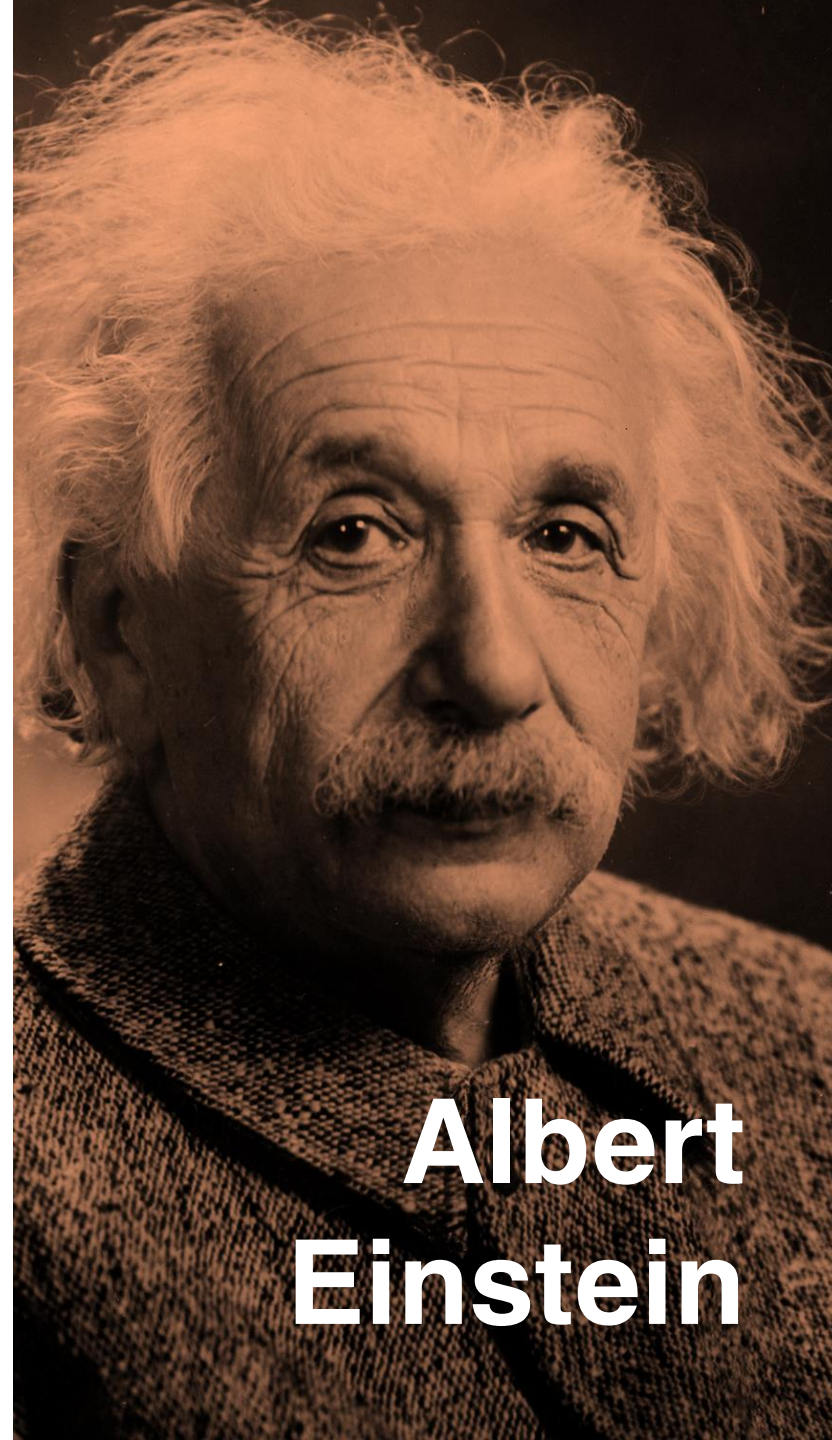
**Max
Planck**

Blackbody

Theoretical object that absorbs all EM wave and emits radiation whose spectrum is based on temperature alone.

1905:

Light exists in
discrete
bundles of
energy called
Photons.



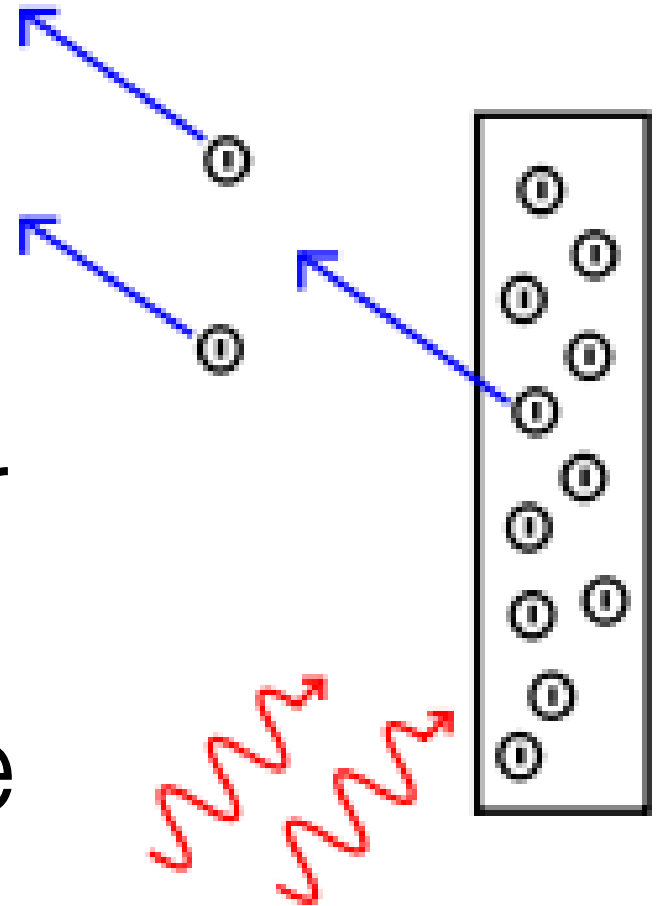
**Albert
Einstein**

1921:

Einstein awarded Nobel
Prize for the
Photoelectric Effect.

Photoelectric Effect

production
of electron or other
free carriers
when light is shone
onto a material



1930:

Quantum
Electrodynamics
merged both.

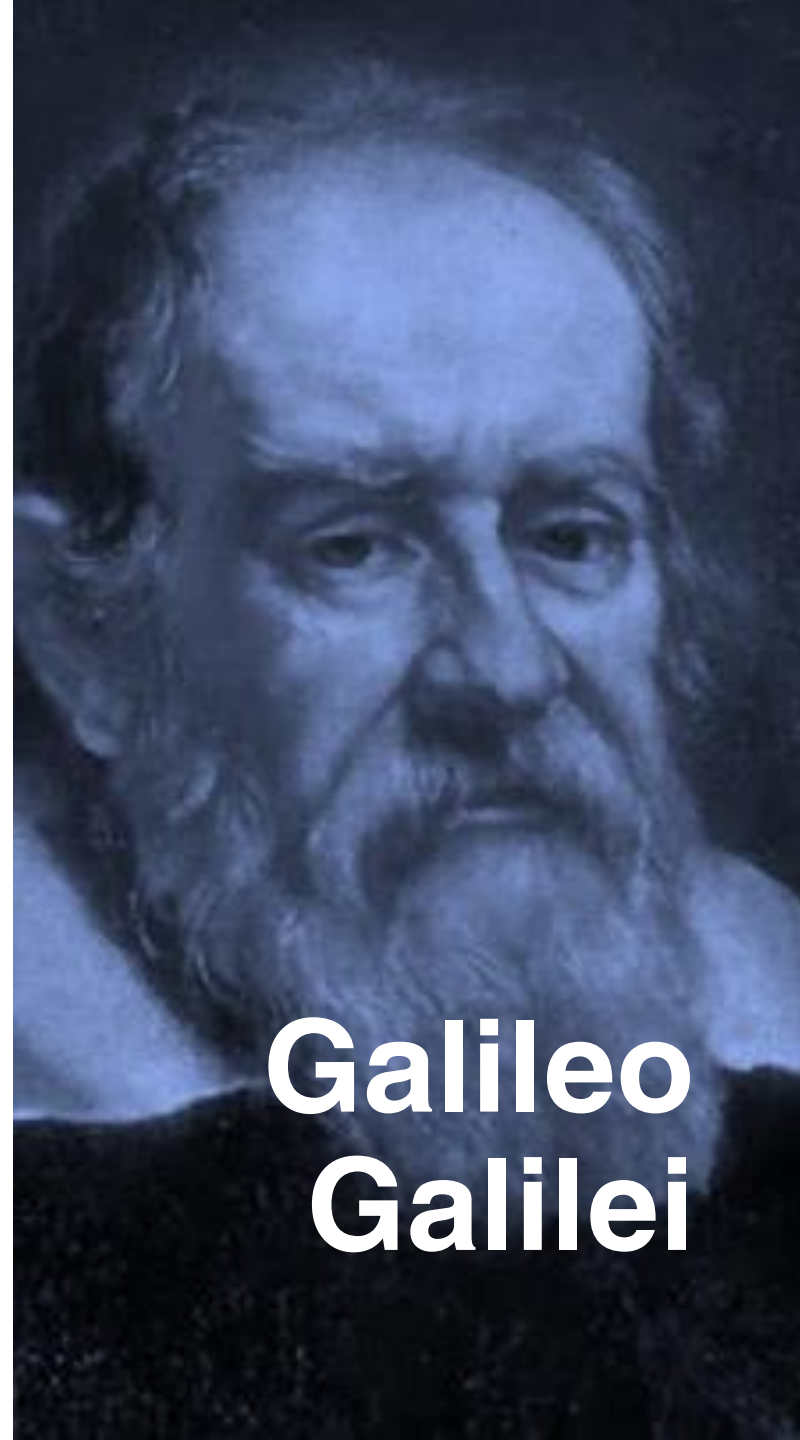
Wave Model

best describes
propagation.

Particle Model
for emissions and
absorption.

Speed of Light

Hypothesized
that Light
had speed.



**Galileo
Galilei**

First person
to measure
speed of
light.

220M m/s

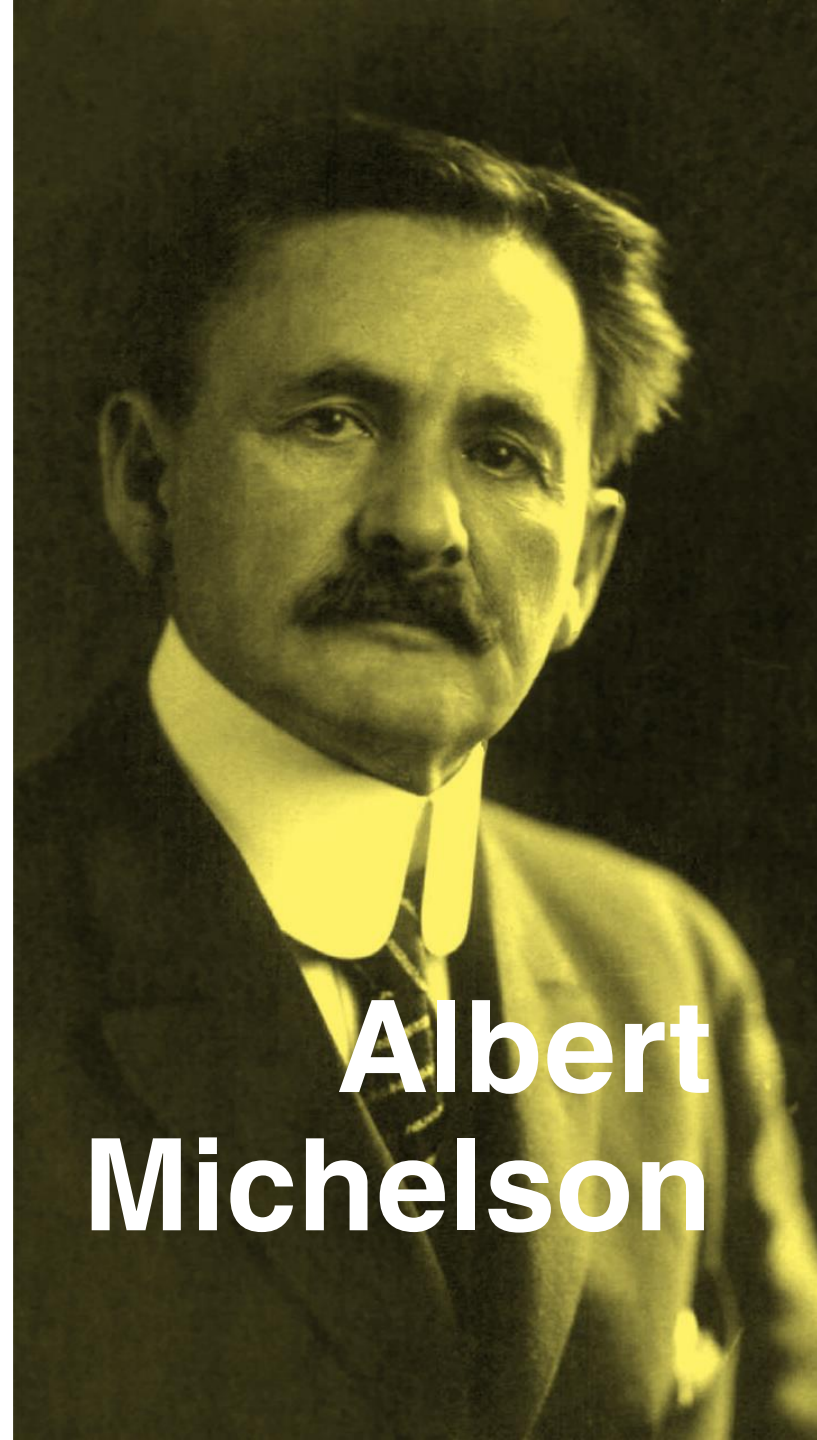


**Ole
Rømer**

Speed of Light

2.9979×10^8

m/s



**Albert
Michelson**

Sources & Propagation

Optics

Branch of Physics
involving behavior of
Light

Light

Being an EM wave, is
a combination of
Electric & Magnetic
Energy

Luminous v. Non- Luminous

Luminous Objects

Emit their own light Non-
Luminous Objects do not.

Incandescence v. luminescence

Incandescence is light due to a hot body.

Luminescence is light due to other sources.

Types of luminescence

Flourescence is light lasting $< 10\text{ns}$. Phosphoresence is light $> 10\text{ns}$.

Types of photoluminescence

Flourescence is light lasting $< 10\text{ns}$ due to jumping of electrons from one energy state to ground.

Types of photoluminescence

Phosphorescence is light lasting $> 10\text{ns}$ due to emission of photons trapped' in a forbidden state.

Opaque v transparent v translucent

Opaque materials does not allow light to pass,

Transparent materials do.

Translucent straddles the two.

Umbra v. Penumbra

Umbra is the uniformly dark portion in the center of the a shadow, **Penumbra** is the uneven 'halo' around a shadow.

Fermat's Principle of Least Time states that light will take the most efficient path that requires the least time.

Will be discussed further this in reflection & refraction.

Photometry branch of optics which deals with measurements of light relative to human eye.

(As opposed to **radiometry** which deals with radiant energy (including light) on an absolute scale)

Luminous Intensity v. Luminous Flux

Luminous Intensity measure of perceived power in a particular direction.

Measured using SI Unit
candela (cd).

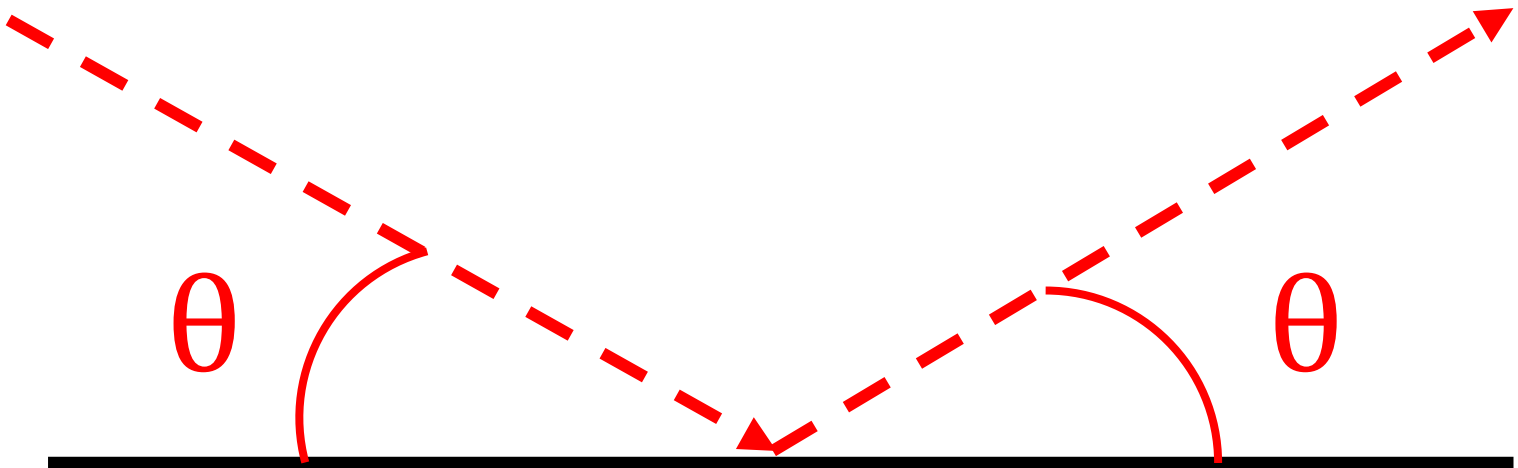
Reflection

echo:sound = reflection:light

‘bouncing off’ of light againsts
a surface.

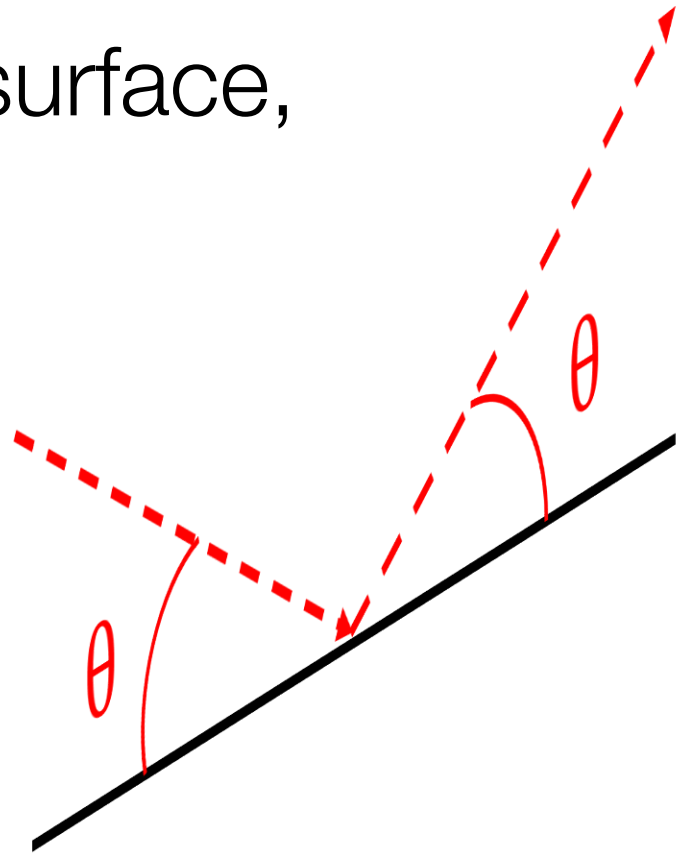
Reflection

Angle of incidence = angle of reflection



Reflection

Incident, reflected and surface,
All on the same plane



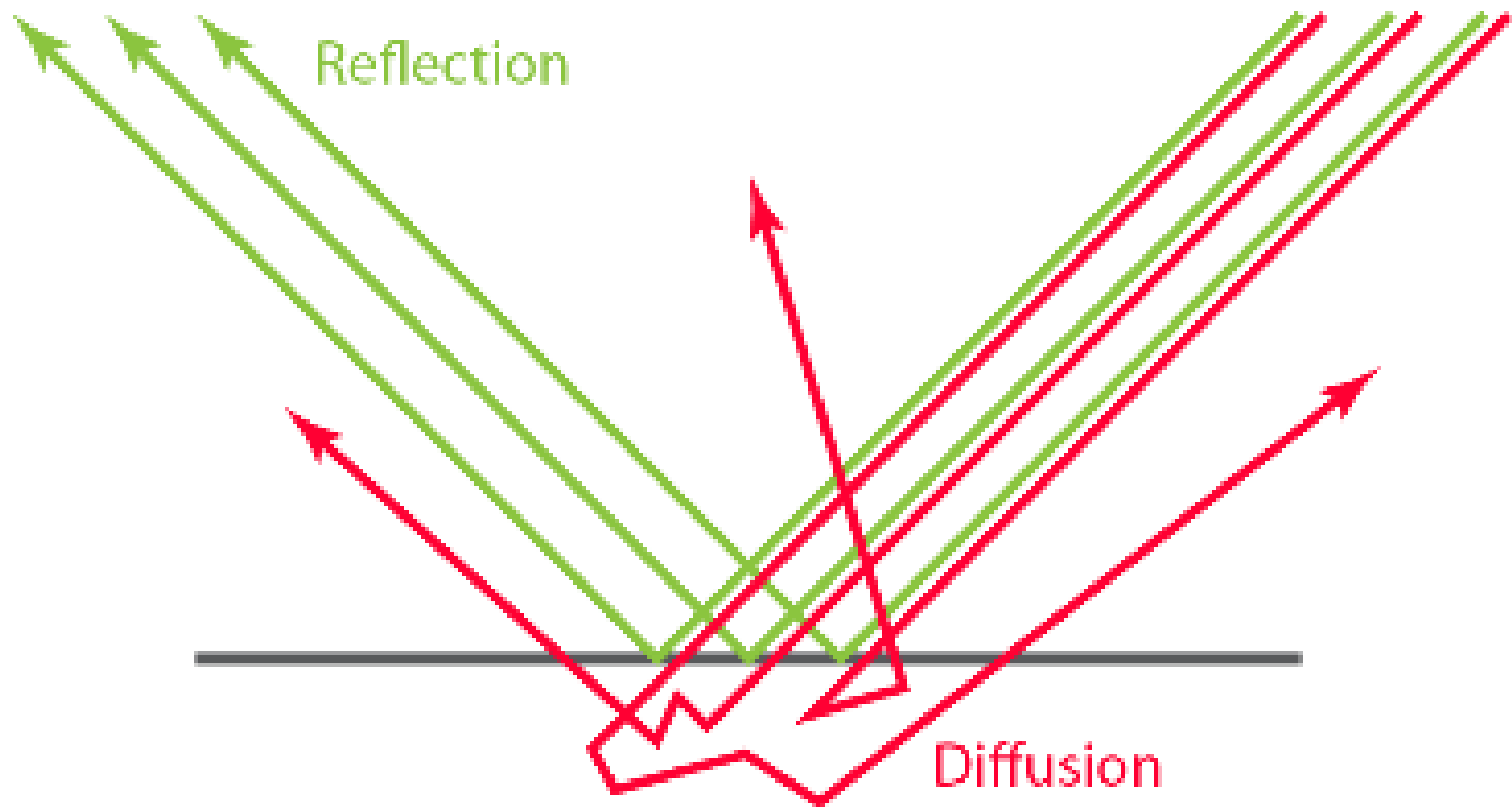
2 Kinds of Reflection

Specular reflection when the reflecting surface is smooth and even. Diffuse reflection if rough and uneven.

Diffusion

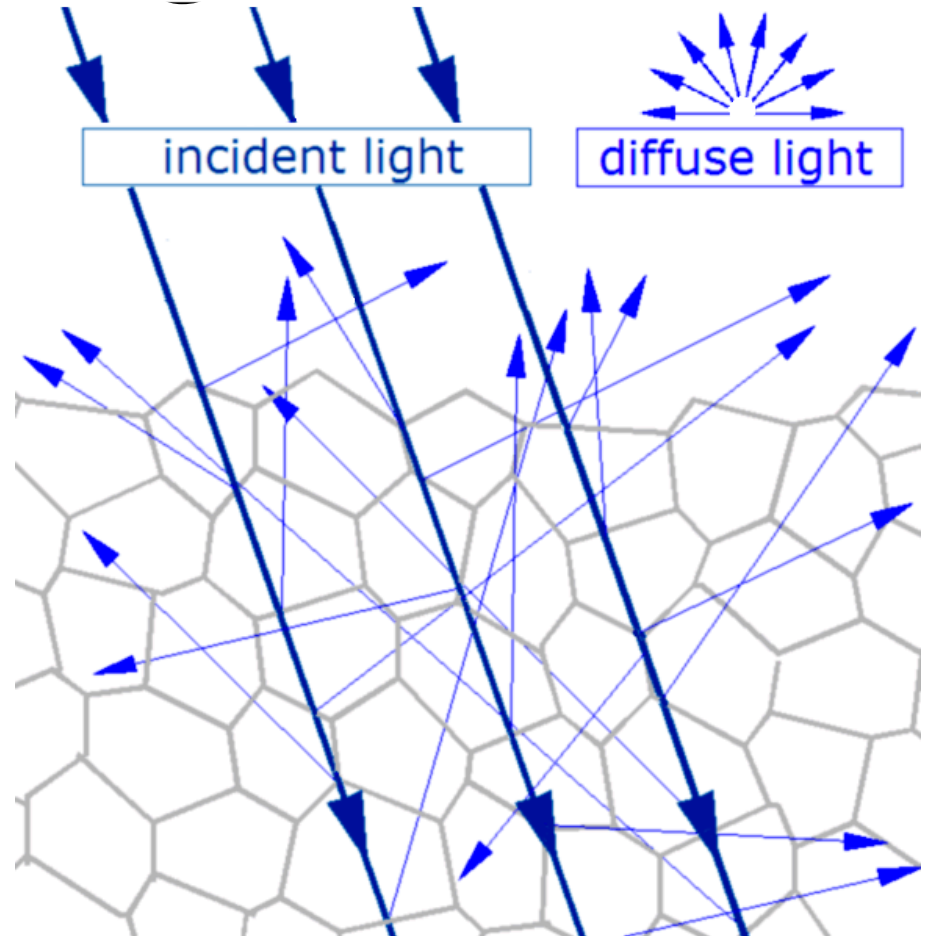
Dispersal (splitting up and distributing in all directions) of reflected light.

Diffusion

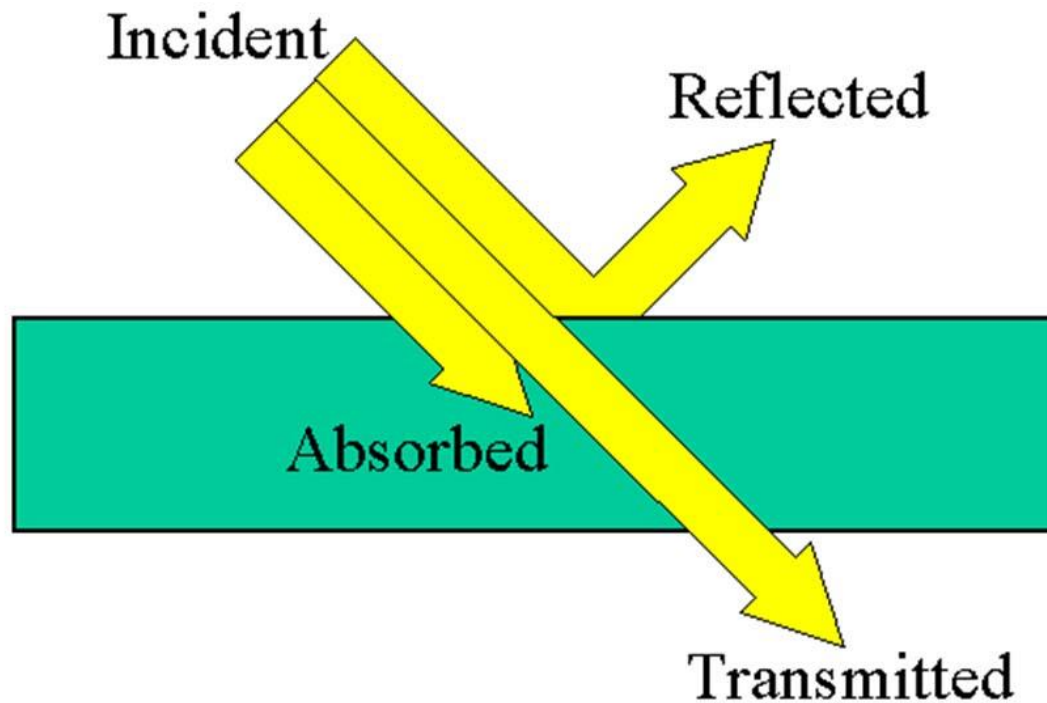


Light Scattering

The dispersal of light due to irregularities (particles) in the medium

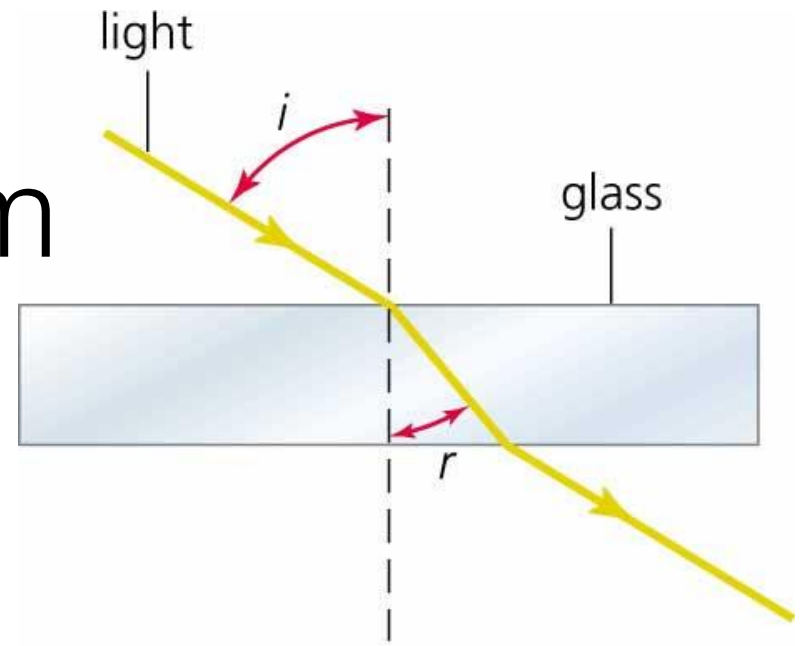


Reflection v Absorption v Transmission



Refraction

Bending of light as it passes from one medium to another.



Refraction

Due to changing velocity of light based on medium.

The 'c' we know 3.0×10^8 is only for a vacuum.

Index of Refraction

The ratio by which the velocity of light changes from one medium to another.

Index of Refraction

Air = 1.0

Ice = 1.310

Diamond = 2.417

Water = 1.333

Index of Refraction

$$n = \frac{c}{v}$$

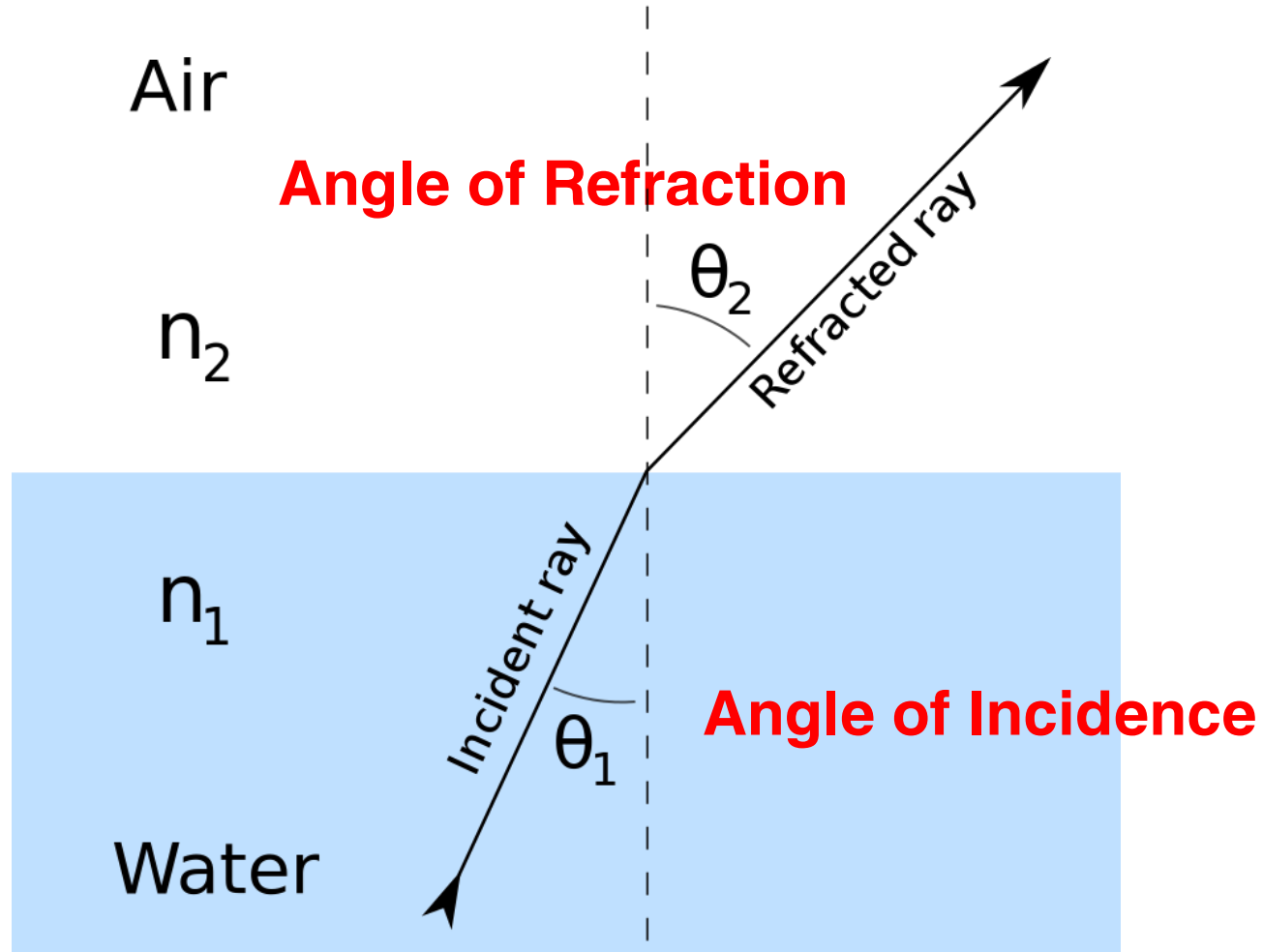
n = index of refraction

$c = 3 \times 10^8$ m/s

(velocity of light in vacuum.)

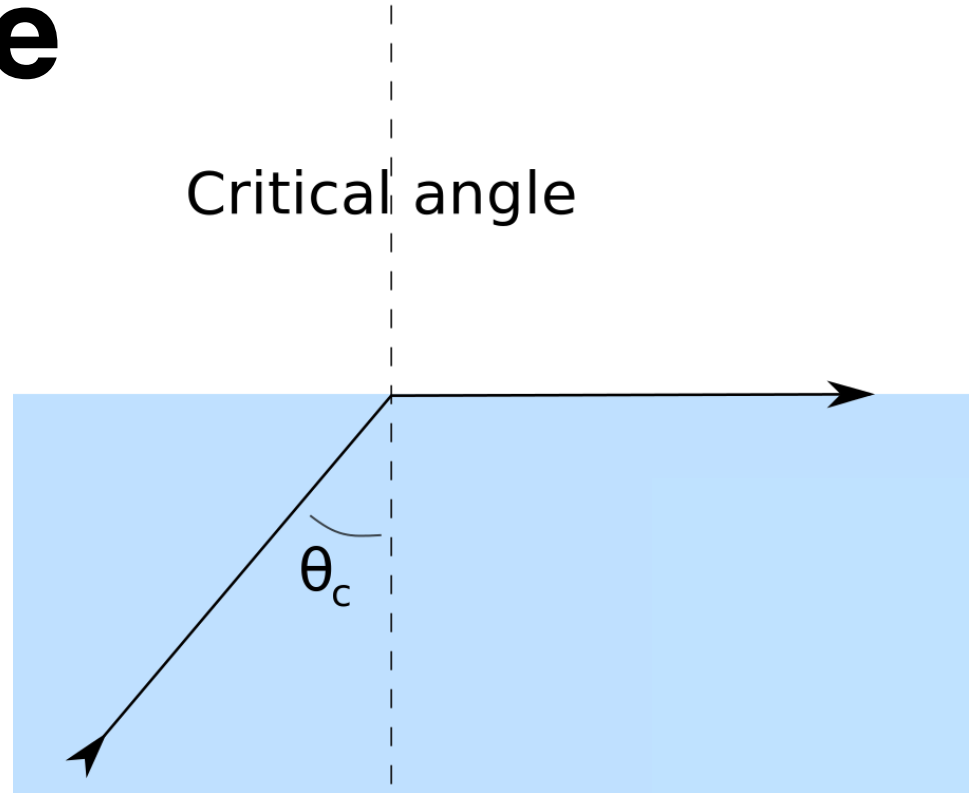
v = velocity in medium

Angle of Incidence & Refraction



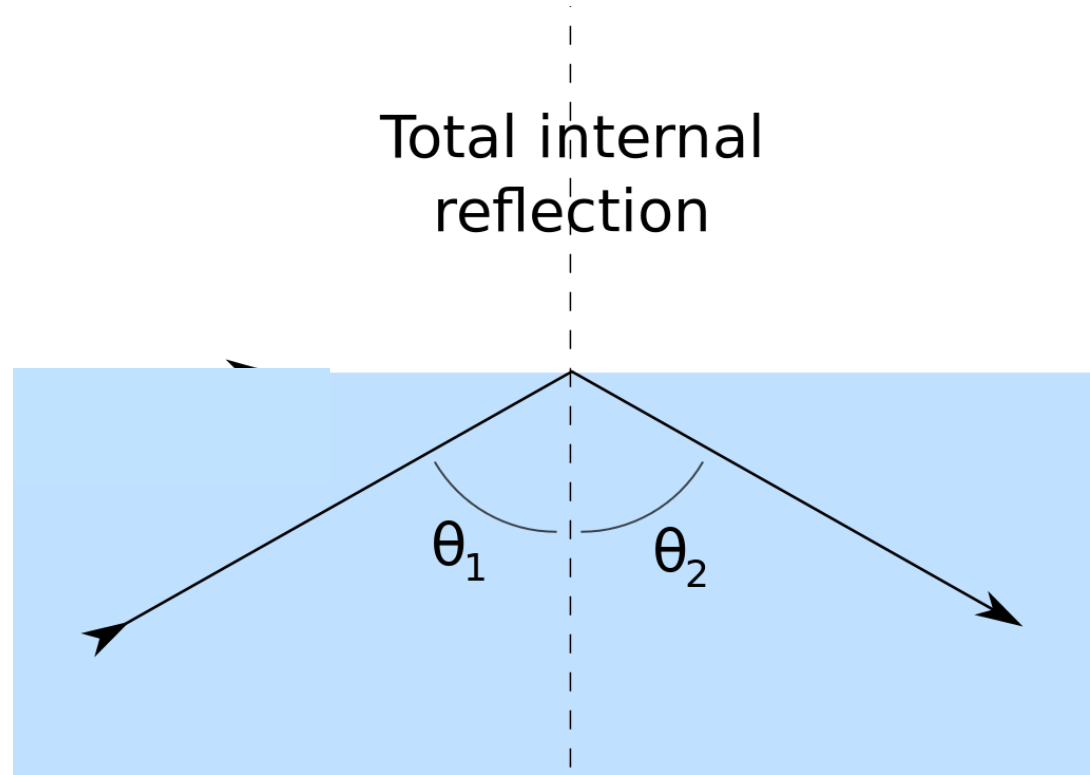
Critical Angle

the angle of incidence that produces an angle of refraction = 90°



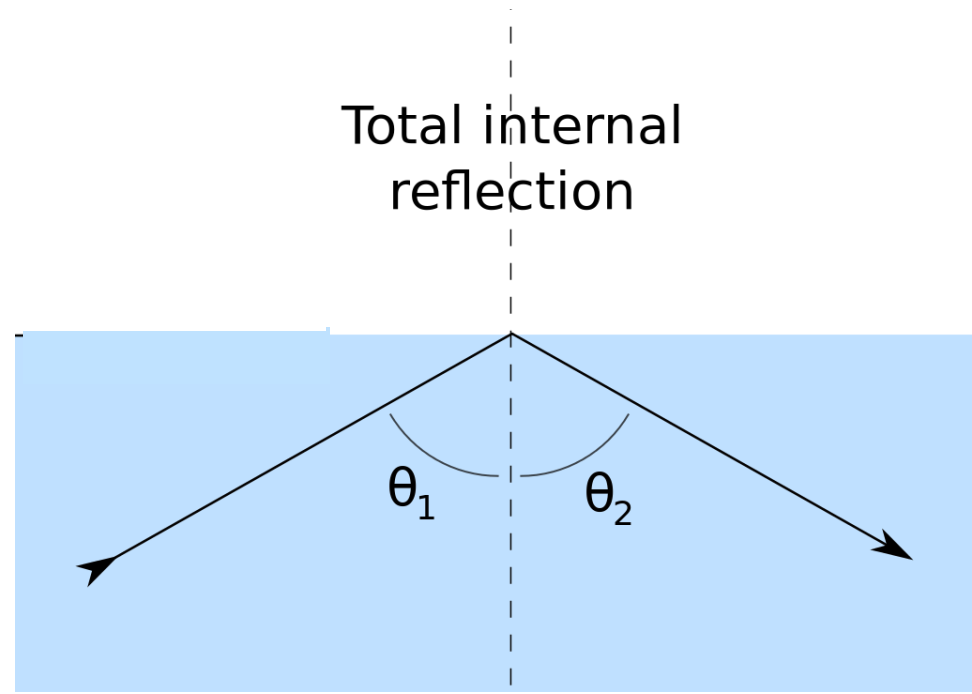
Total Internal Reflection

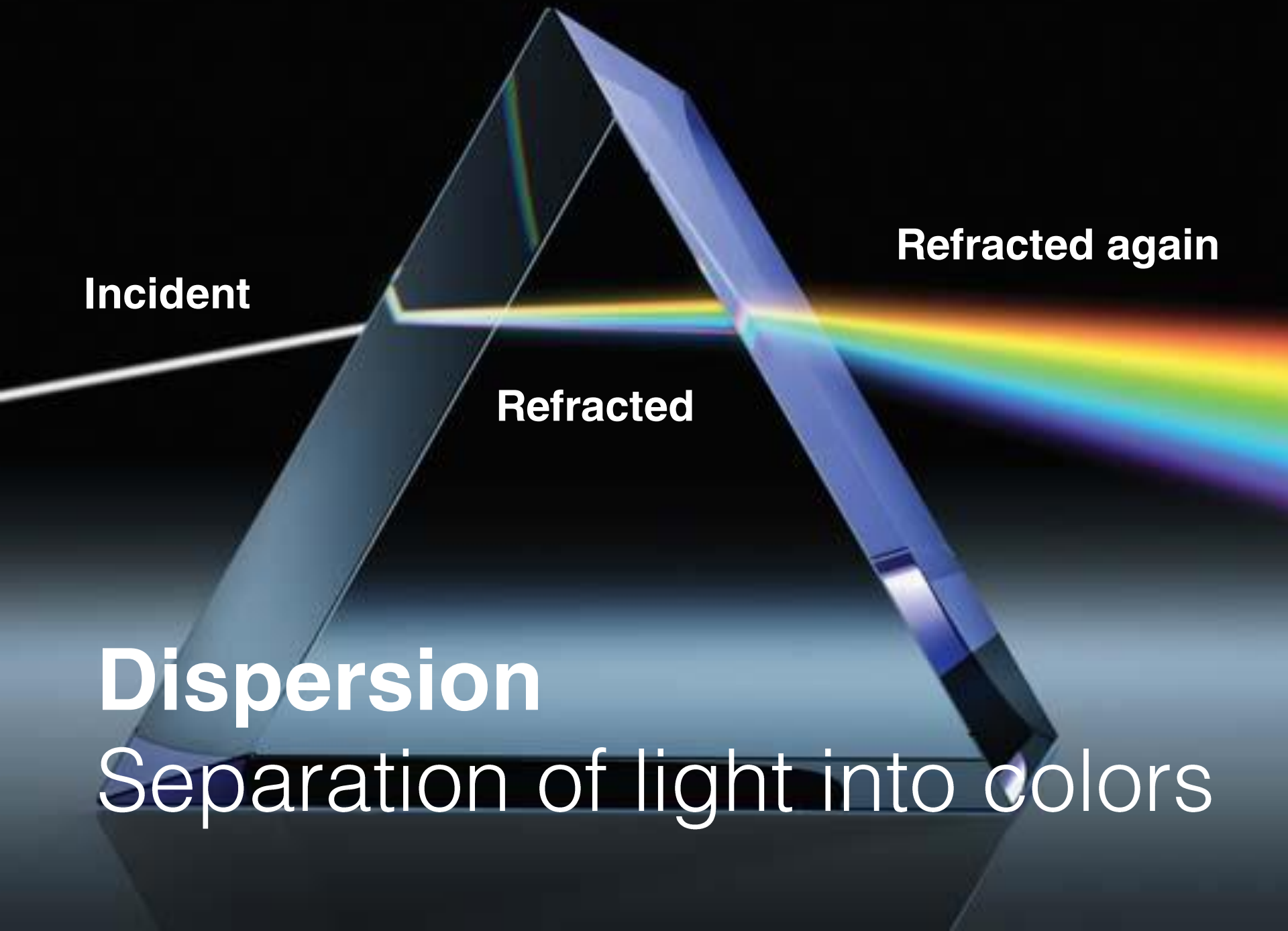
Boundary acts like a perfect reflector.



Total Internal Reflection

- Angle of incidence $>$ critical angle
- From dense (high n) to less dense (low n)





Incident

Refracted again

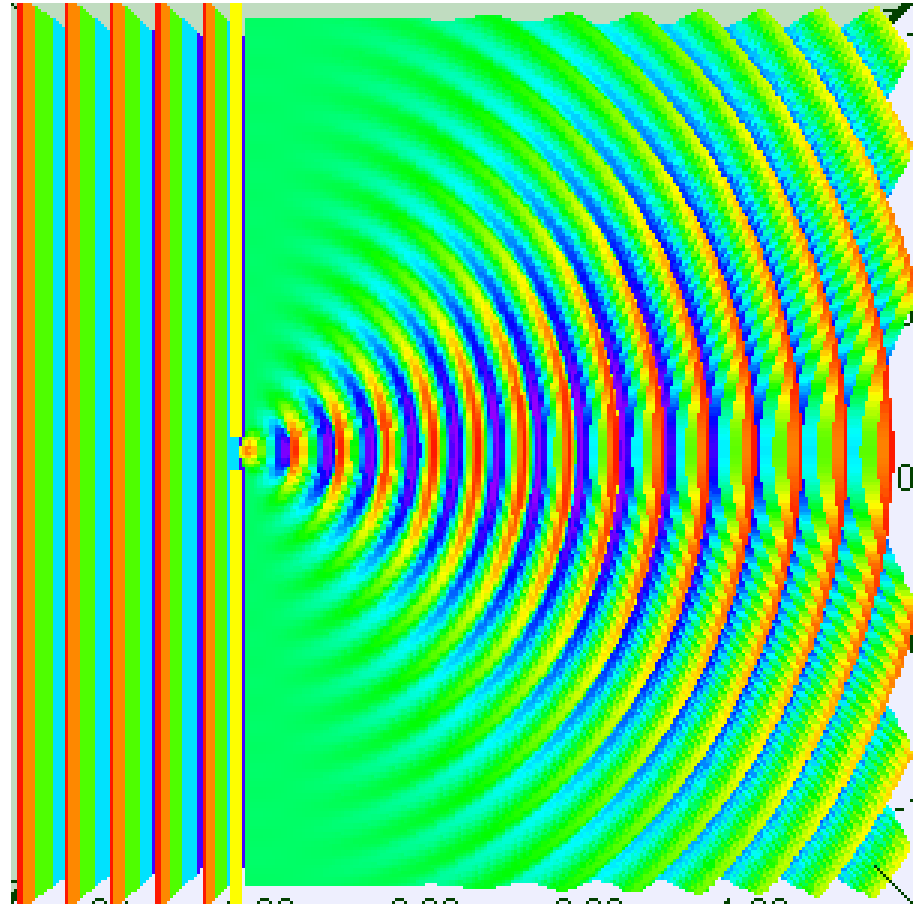
Refracted

Dispersion

Separation of light into colors

Diffraction

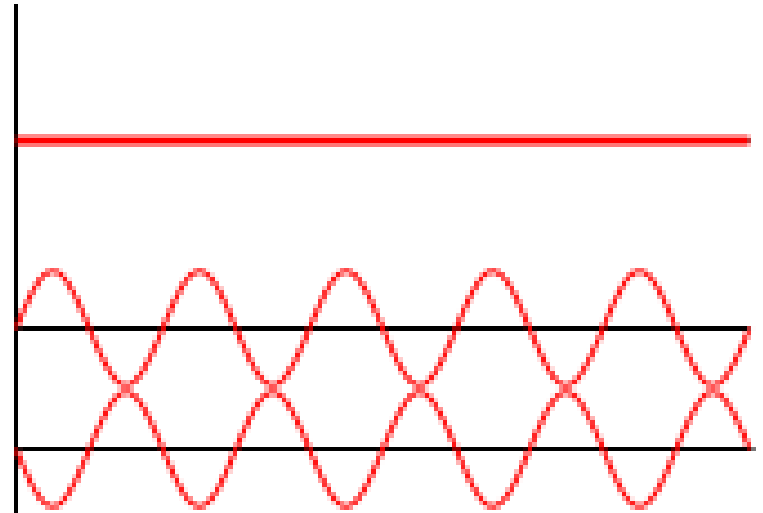
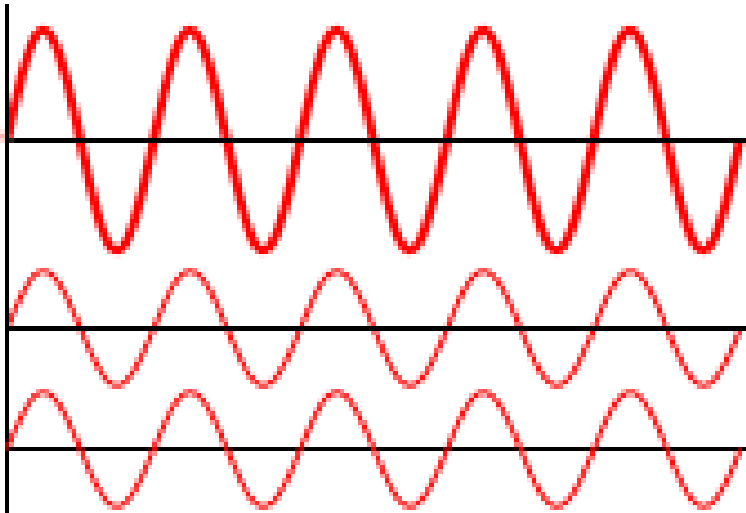
Bending of light around obstacles or apertures (small holes)*.



*Remember Huygens's Principle?

Interference

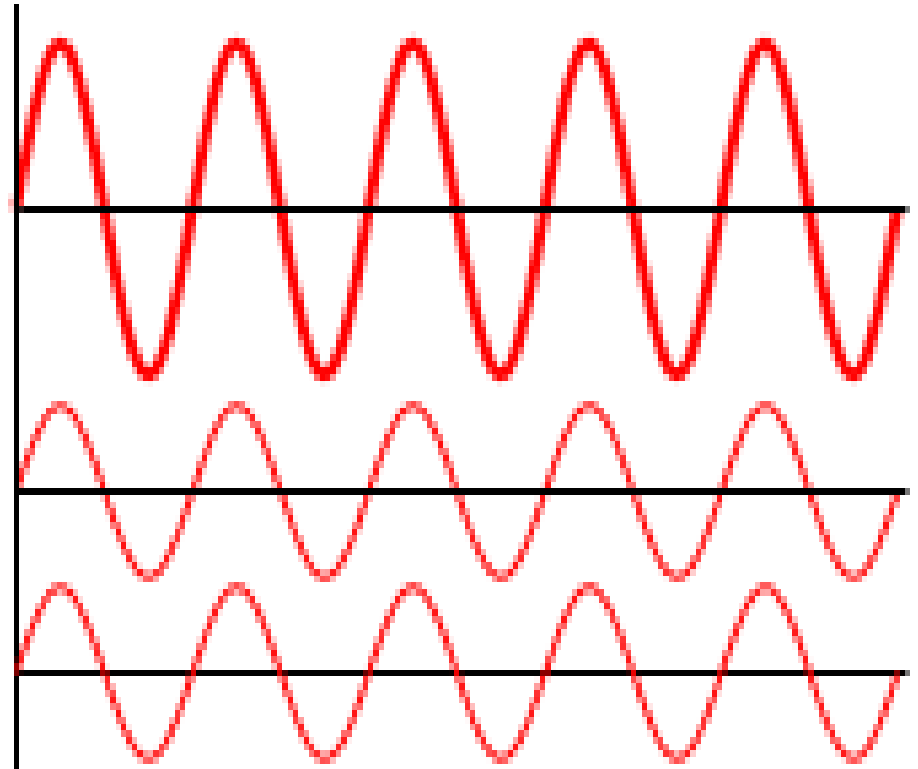
When waves 'overlap' they form a resultant wave.



Constructive Interference

When overlapping waves are **in-phase**.

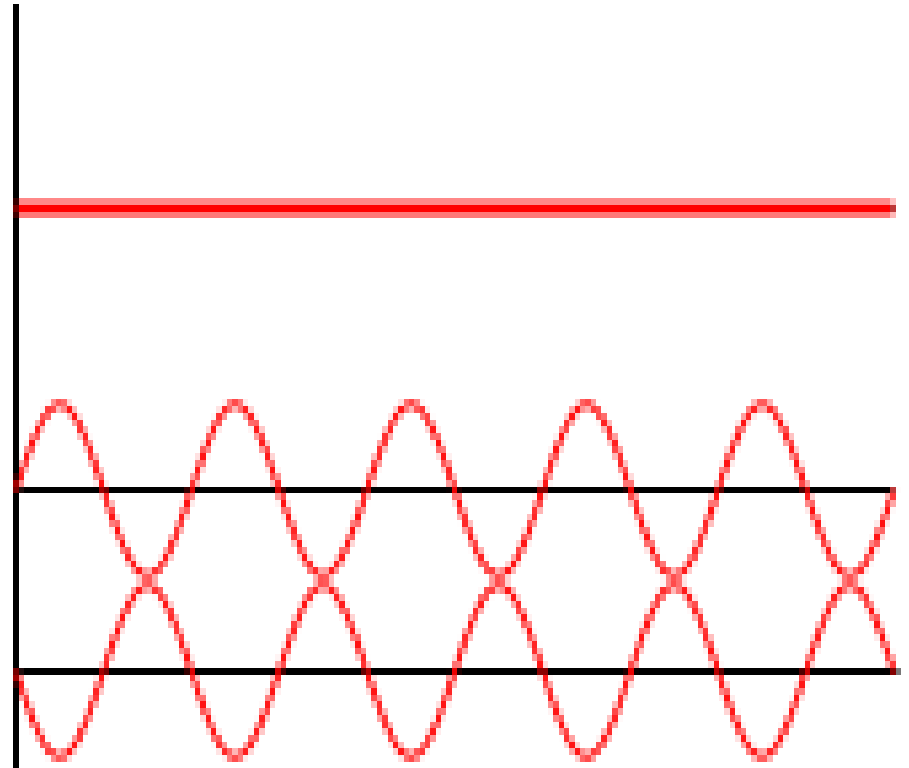
Resultant Wave has higher amplitude



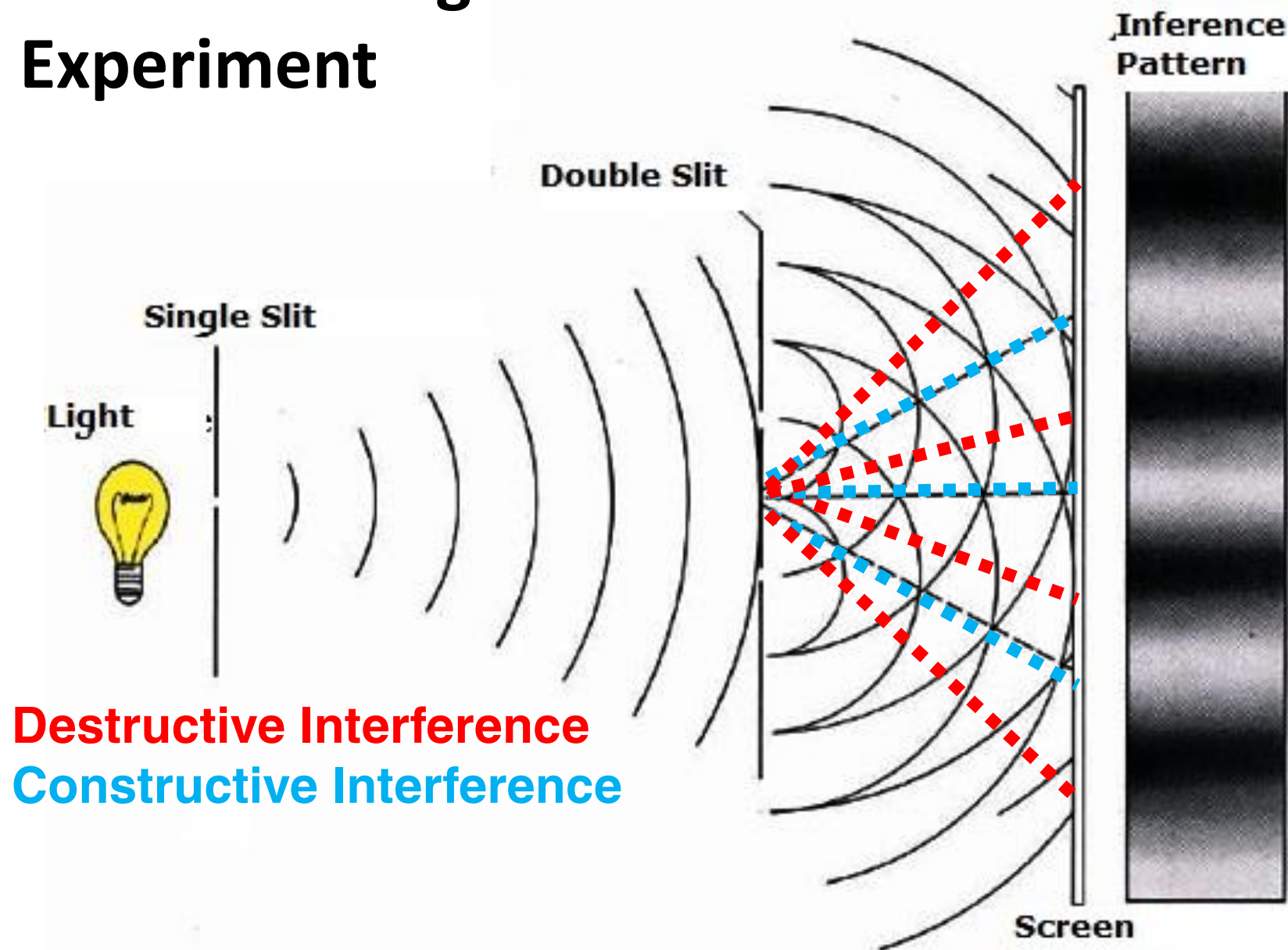
Constructive Interference

When overlapping waves are in **antiphase**.

Resultant Wave has lower (or even 0) amplitude



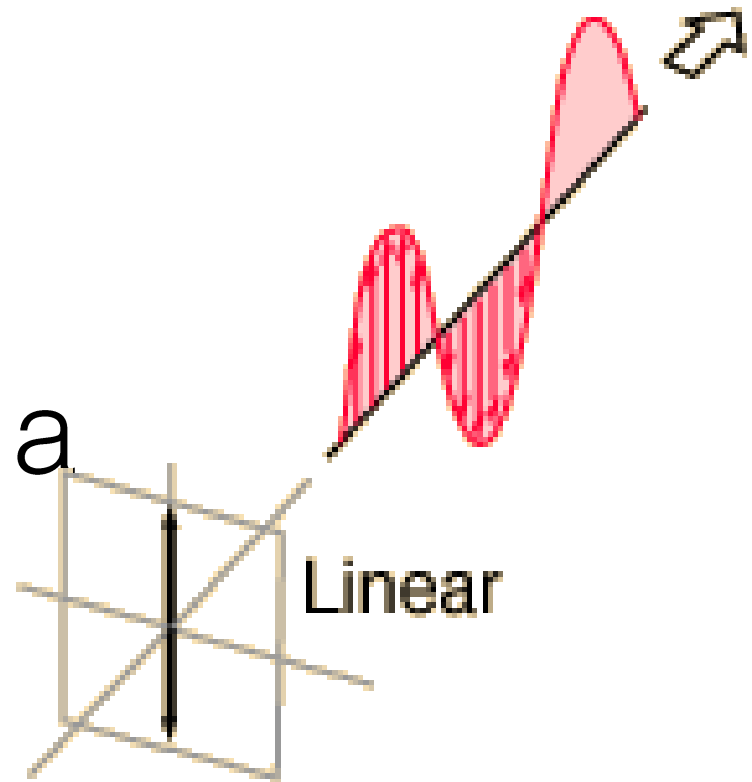
Thomas Young's Double Slit Experiment



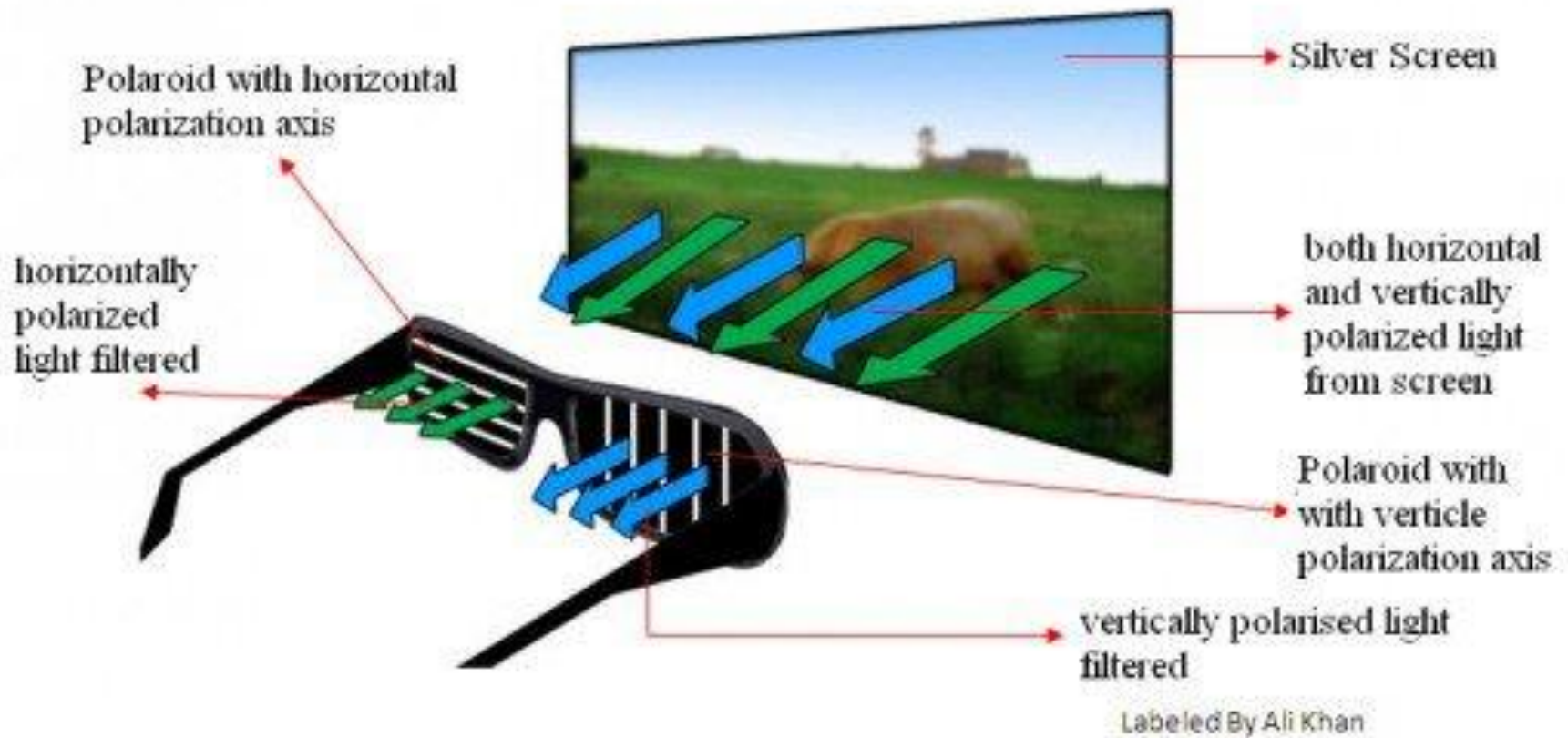
Polarization is the
'orientation' of the
vibrations in waves

Linear Polarization

It can vibrate on a
single plane.*



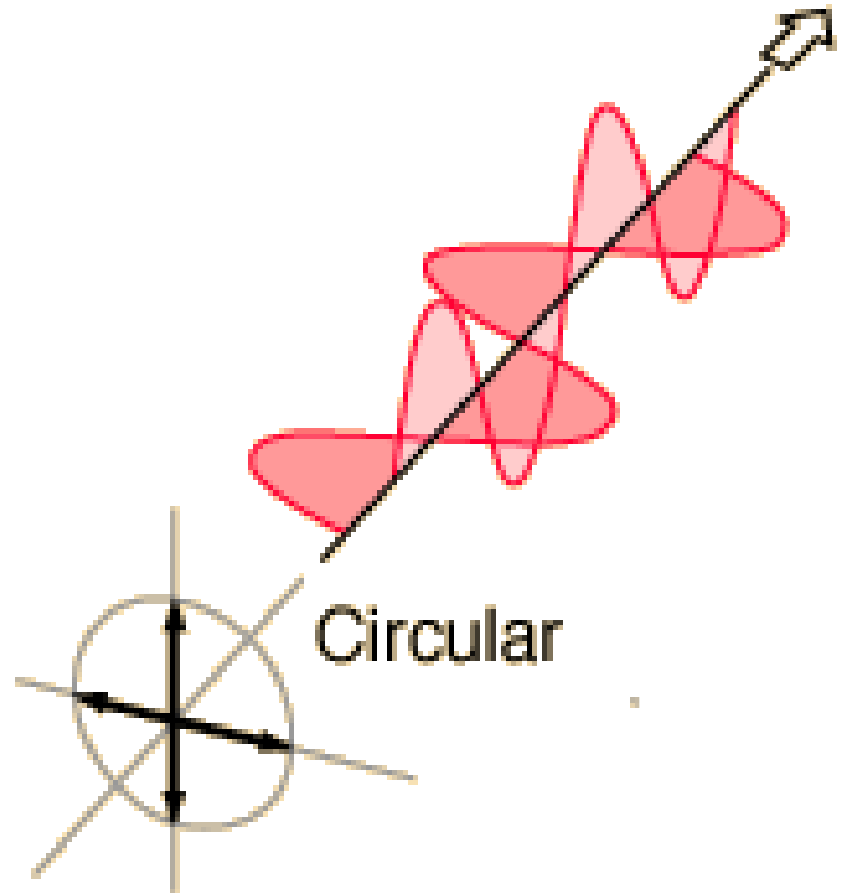
*This is how polarized glasses in 3D Cinemas work.



***thus brightness is 50% only of original image**

Circular Polarization

It can vibrate on 2 planes. 90° out of phase with each other and equal amplitudes in both.



Elliptical Polarization

It can vibrate on 2 planes. 90° out of phase of each other with unequal amplitudes.

