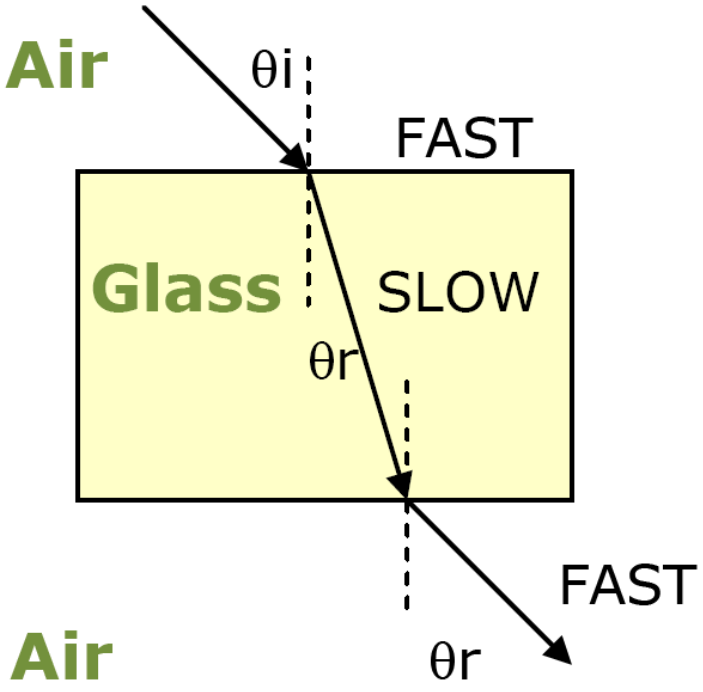
Reflection and Refraction Notes



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IV. Light

A. _____

1. _____ = c (in vacuum) (fastest speed in universe)

In air v ≈ _____

c = f_____ f = c / _____

Frequency and wavelength relationship? _____

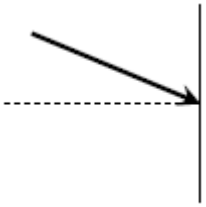
Ex) What is the wavelength of light with a frequency of 7.69×10^{14} Hz in a vacuum?

2. The _____ of light depends on its _____

B. <u>Reflection</u>

1. Law of Reflection

a. ∠ of incidence = ∠ of _____



θin = ∠ incidence (∠ incoming ray makes with the normal)
θr = ∠ reflection (∠ reflected light makes with the normal)

What is the smallest mirror you need to see your whole body? _____

The image from a plane mirror:

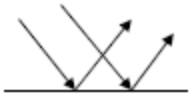
a. Virtual (_____)and _____

b. Incident ray, normal line, and reflected rays are all in the _____ _____

c. The distance the object is in **front** of the mirror_____ the distance the image is _____

2. Two Basic Kinds of Reflection

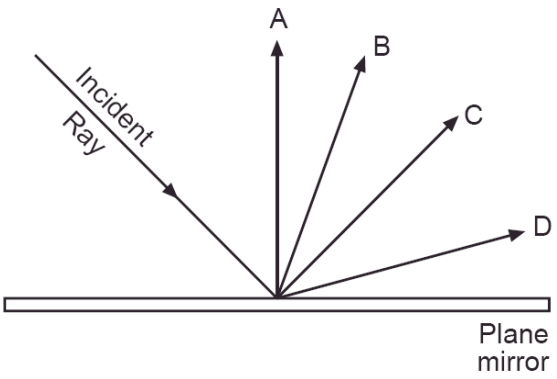
a. Regular Reflection – reflection off a _____ surface (produces _____)



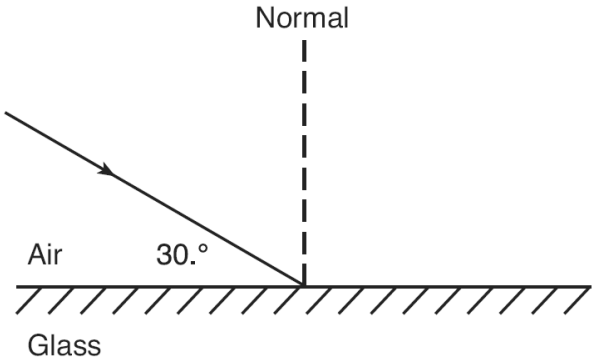
b. Diffuse Reflection – reflection off an **irregular** surface causing light to _____ (no image)



Which reflected ray is correct? _____



Angle of Reflection? _____

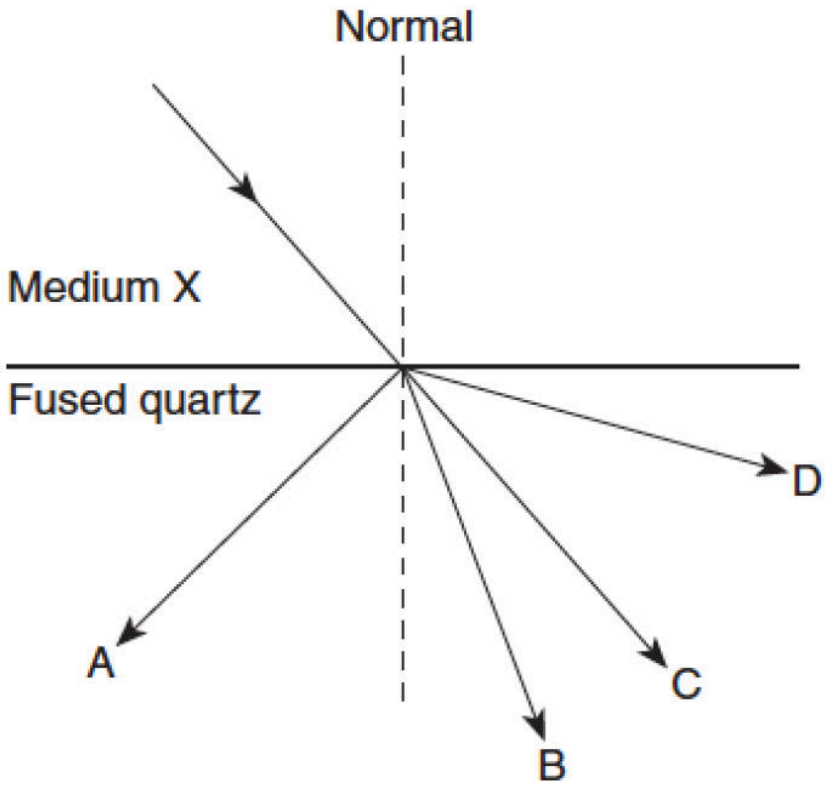


C. **Refraction** – the _____ that occurs

when a light wave _____

1. Speed and Refraction

The _____the medium, the _____the _____a light ray makes with the normal



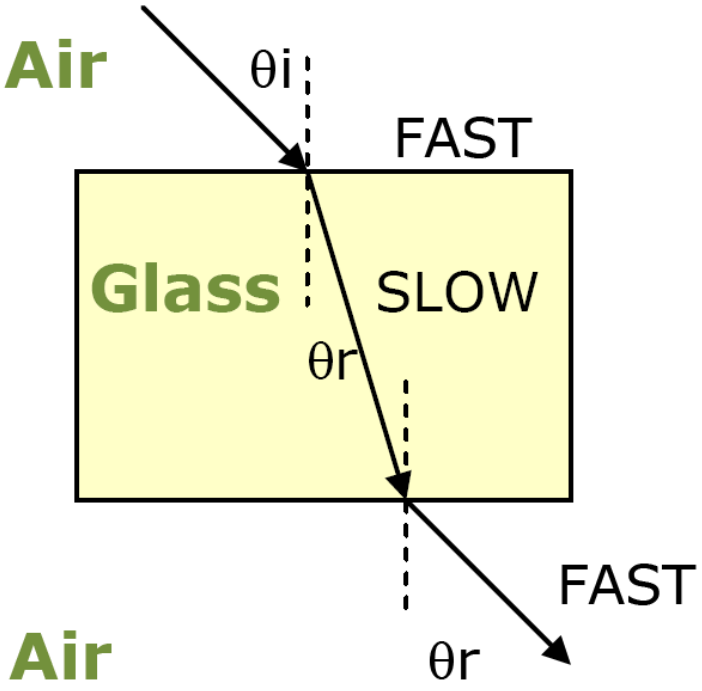
1. If Fused Quartz is faster than medium X? Which Ray? _____
   Explain how you know _____

2. If Fused Quartz is slower than medium X? Which Ray? _____

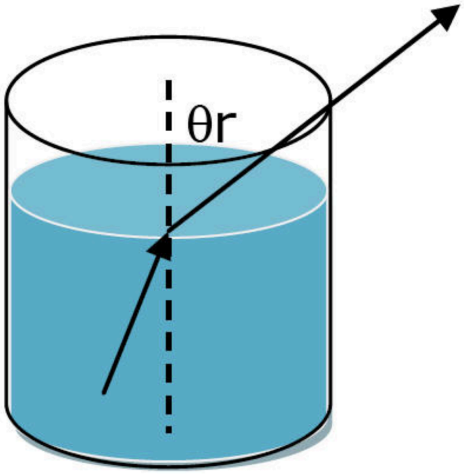
3. If Fused Quartz is the same speed as medium X? Which Ray? _____
4. Which ray is not possible? _____ Why? _____

If Light goes from _____ medium to _____, light bends

_____the normal



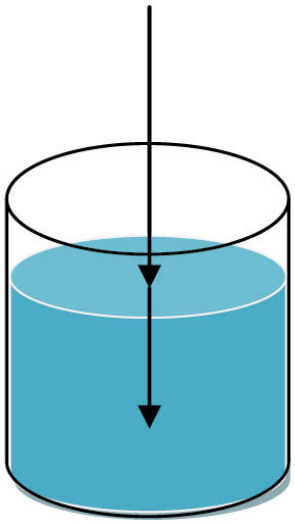
_____medium to _____, light bends _____from the normal



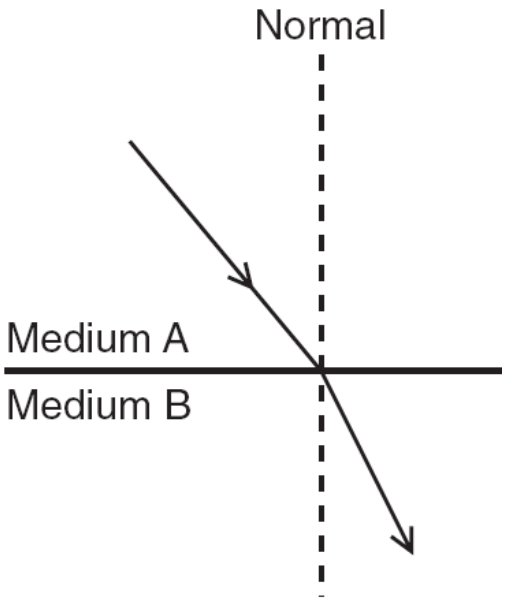
Light Ray leaving water and entering Air

Velocity of Air > Velocity of _____

When Θ of incidence = _____, there is **no** _____



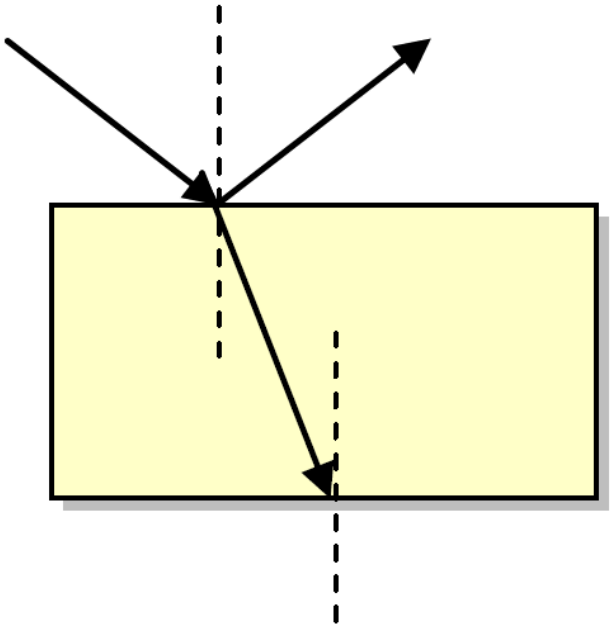
Which medium is faster? Why?



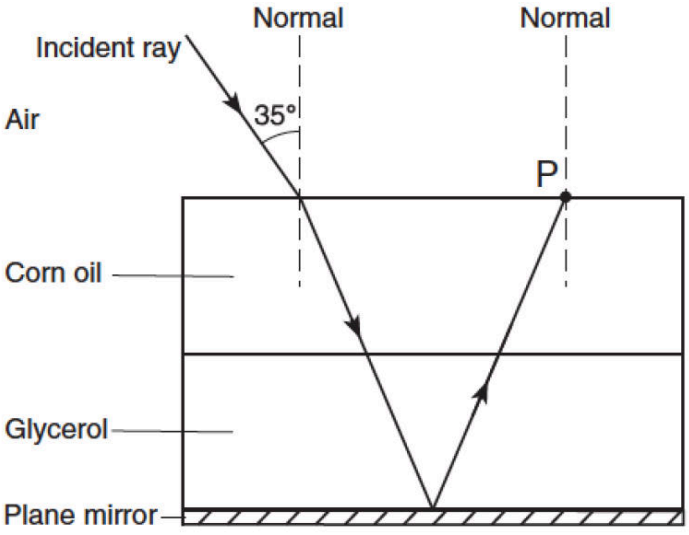
Light must come in at an _____ to be _____

_____ IS ALWAYS ACCOMPANIED BY _____

When a wave enters another medium, part of the wave is _____ and part is _____.



At what angle will the ray reenter the air?



D. **Index of Refraction** (n) – a comparison of the _____

in a substance to its _____

$$n = c/v$$

If a substance has an _____ it means

light is _____ in a vacuum than it is in that medium

n = _____

c = speed of light in a _____ (_____ m/s)

v = speed of light in a _____

n vacuum = _____ n air ≈ _____

Which substance slows down light the most when light enters from air? _____

The least? _____

Example 1) What is the speed of light in alcohol?

Absolute Indices of Refraction ($f = 5.09 \times 10^{14}$ Hz)	
Air	1.00
Corn oil	1.47
Diamond	2.42
Ethyl alcohol	1.36
Glass, crown	1.52
Glass, flint	1.66
Glycerol	1.47
Lucite	1.50
Quartz, fused	1.46
Sodium chloride	1.54
Water	1.33
Zircon	1.92

Show work here

n =

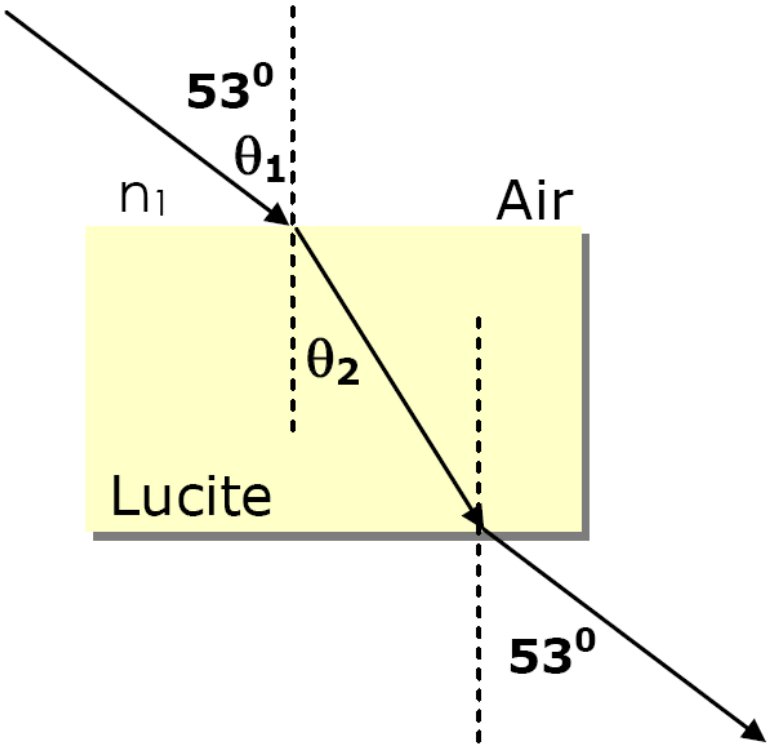
n =

Mathematical relationship between n & v is _____

n = ___

The more light is _____, the more it _____

1. **Prediction Θ_{ref} from Θ_{in}**



a. Snell's Law _____ On Reference Table

1 – incident medium 2 – refractive medium

Ex) Light travels from air into Lucite with an angle of incidence of 53°. Find the angle of refraction.

Air **Lucite**

$n_1 \sin\Theta_1 = n_2 \sin\Theta_2$

Ex) Light refracts as it moves from water to flint glass. Which angle is bigger, θin or

θ_{ref}? _____ Why? _____

b. _____

1 – incident medium

2 – refractive medium

*** When a light changes media, its _____ _____

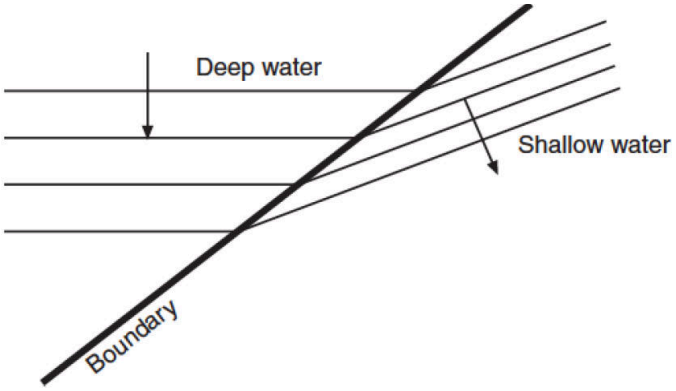
NOT its _____

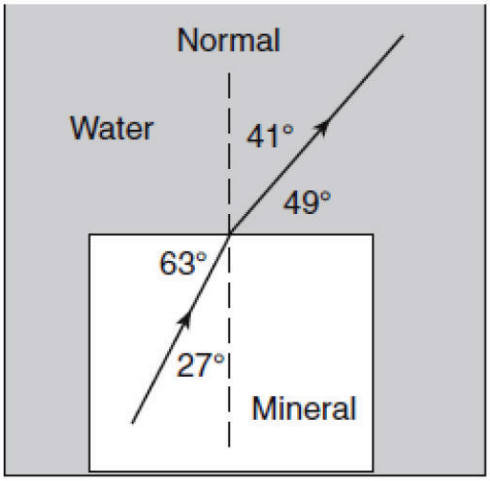
c. _____

When light refracts it _____

_____

Deep Water or shallow? Which is faster?





Angle of Incidence? _____

Angle of Refraction _____

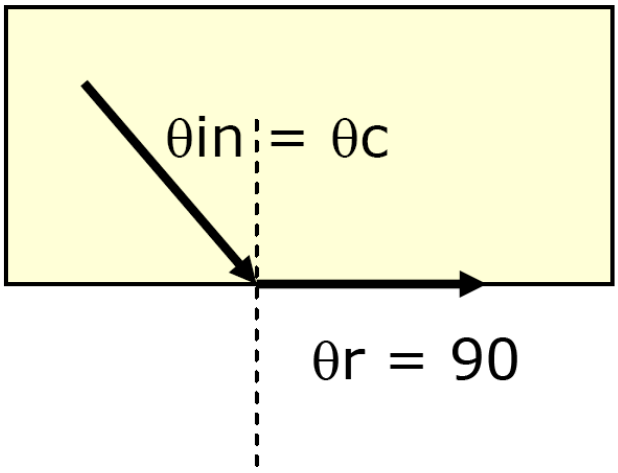
2. **<u>Critical Angle</u>** – **angle of _____** for which the

_____ equals _____ when

light travels inside one medium that _____

_____

Air ($n_2 = 1$)

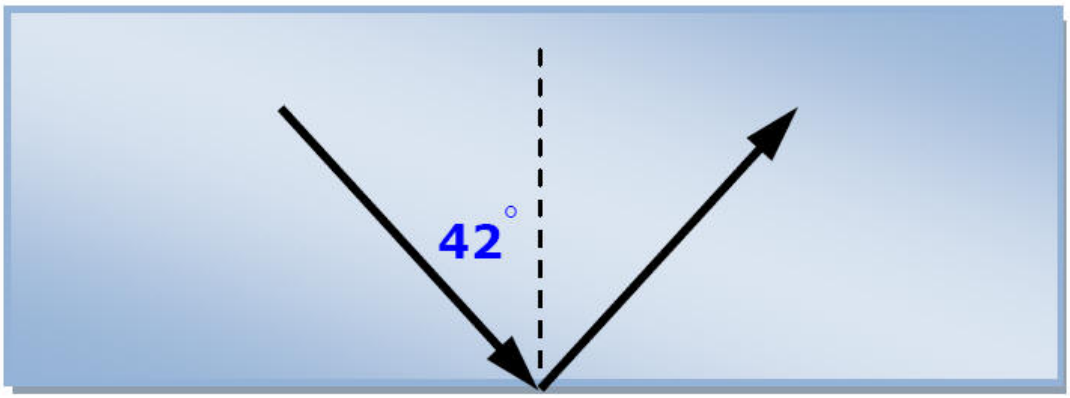


<u>Deriving the critical angle: n1sinθc = n2sin90°, so sin θc = _____</u>

<u>Θc for Lucite</u>

sin <u>Θ</u>c =

3. **<u>Total Internal Reflection</u>** – (High n to Low n)



When $\underline{\theta}_1$ =

When $\underline{\theta}$ >

When $\underline{\theta}$ <

Lucite $\underline{\theta}c$ = 41.8

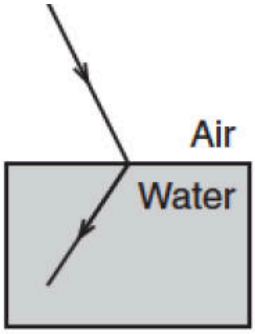
$\underline{\theta}_1$ > 41.8 _____

$\underline{\theta}_1$ < 41.8 _____

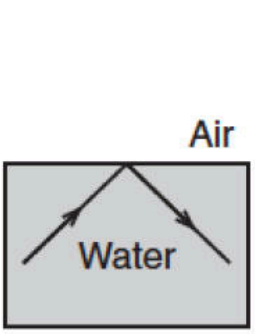
Optical fibers are coated with a low-n (fast) material called _____.

Which diagram correctly show TOTAL INTERNAL REFLECTION? Refraction? _____

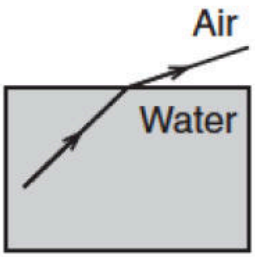
Impossible? _____



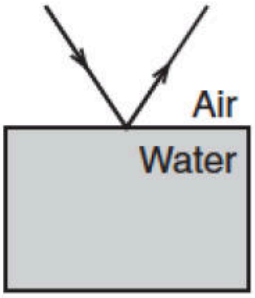
(1)



(2)

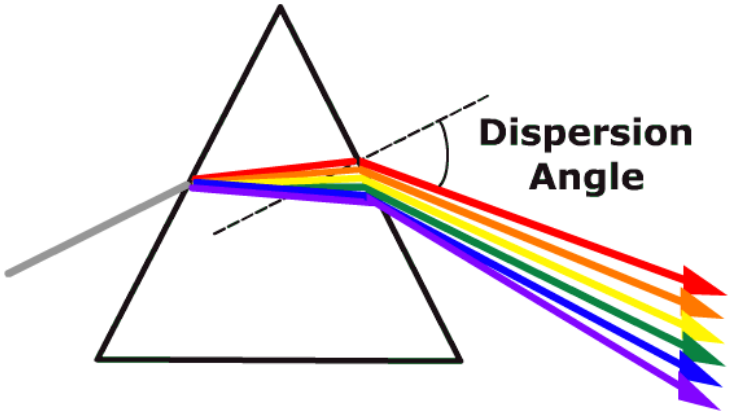


(3)



(4)

1. **Dispersion** – _____ into its component wavelengths (colors)



Fill in the colors for each arrow on the left

Each color has a different _____ (different speeds)

Red - fastest (slowed least), bent least

Violet - slowest (slowed most), bent most

Red – _____ (slowed _____), bent _____

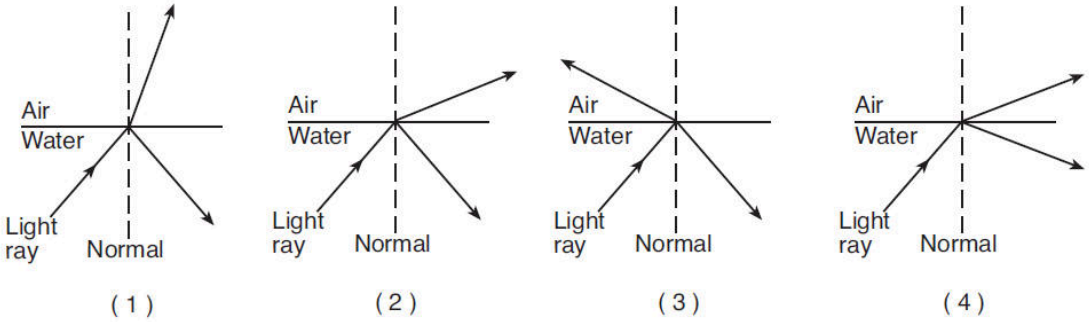
Violet – _____ (slowed _____), bent _____

Dispersive Medium – a medium in which the velocity of a wave depends on its frequency

ex) _____

Nondispersive Medium _____

Which image below is correct?



E. Wave Nature of Light

2 Competing Theories: 1. _____ 2. _____

Behavior of Light Supporting _____

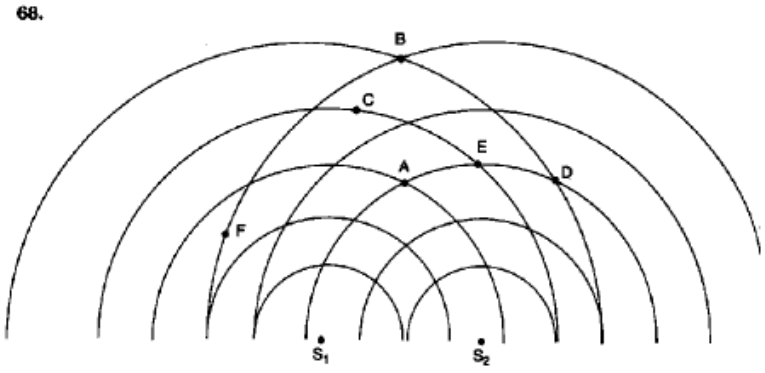
1. _____ – light _____ into the region behind an obstacle



2. _____ – Young's Double Slit Early 1800's

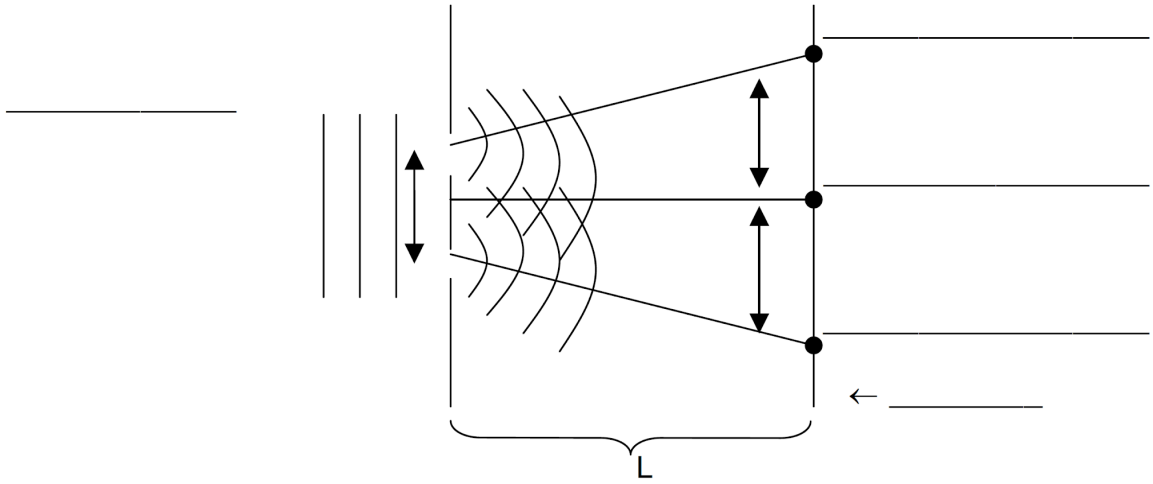
<u>Review of Interference</u>

Lines of Constructive and Destructive Interference



Which points above show …..

Constructive - ____, _____, _____, _____ Destructive _____, _____



A _____, _____ light source was used.
If you draw a line from each slit to the 1st order bright line, you will notice

that one line is longer than another. The **_____** between these two

lines is _____

Destructive interference occurs at a _____, _____, _____ … wavelength difference.

Constructive Interference causes _____ Lines.

Destructive Interference causes _____Lines.

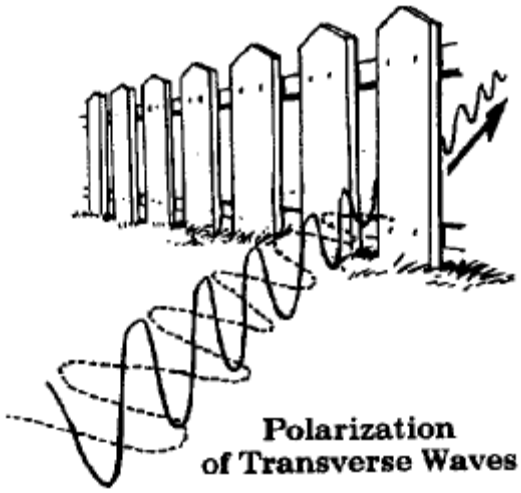
More wave behaviors of light

Polarization - _____ of a beam of light producing light that vibrates in only one plane

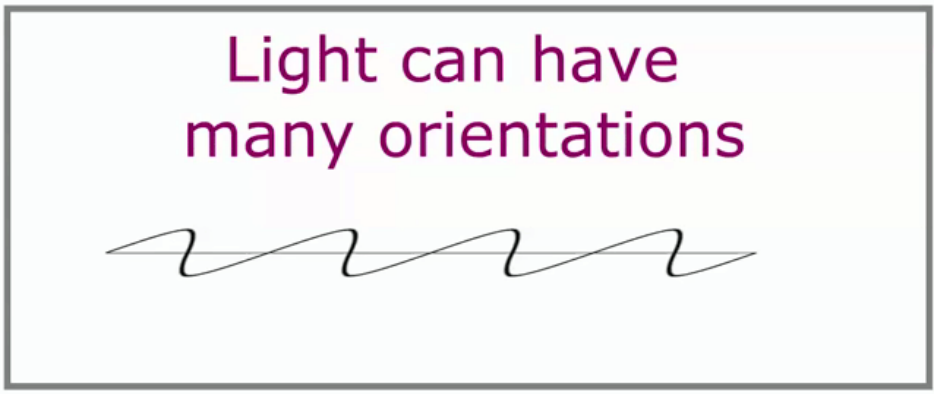
- proves light is a _____ wave

- it has an _____

What's wrong with this picture?



_____of light is _____ to be polarized by a large opening

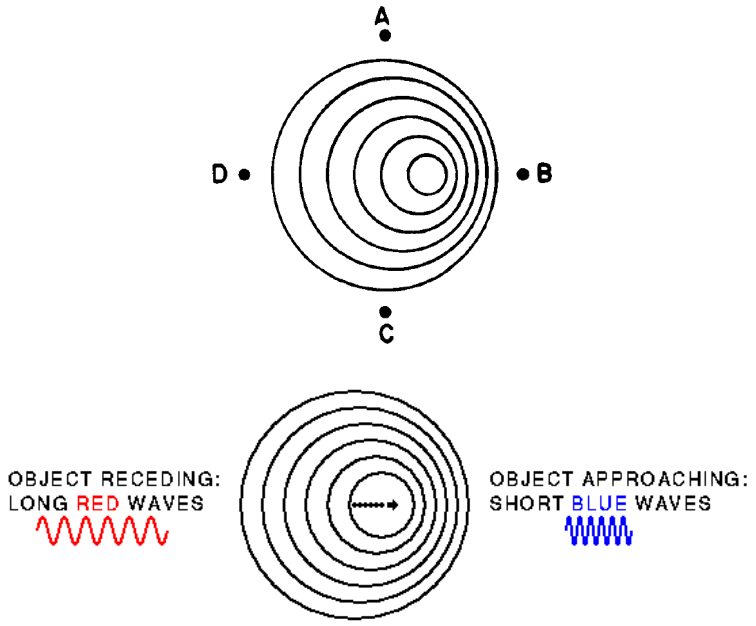


Doppler Effect for light

There is a change in the observed _____**(color)** of

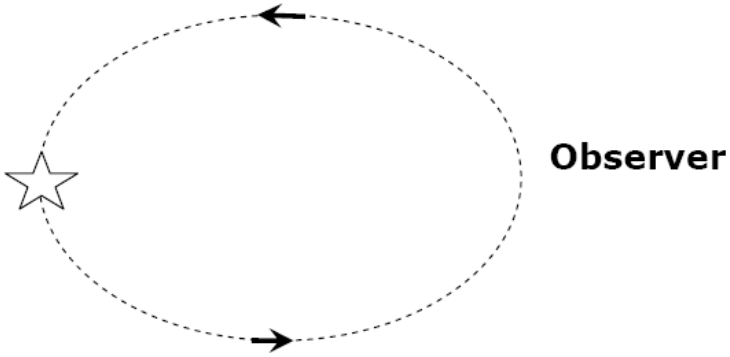
light as a very fast source of the light _____from an observer.

Which way is this wave moving?



¨ Observed in _____moving stars

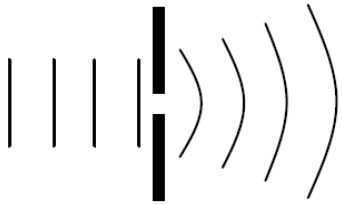
Memory Trick - "_____TO " "_____ AWAY"



Star's colors become _____ Star's colors become _____

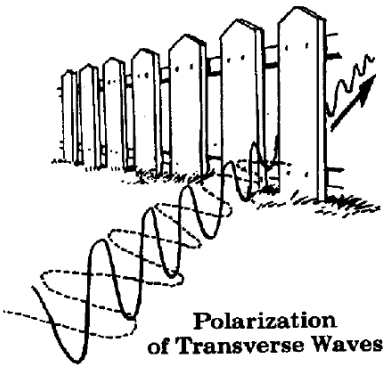
Summary - Why do we think light is a wave?

Diffraction - _____

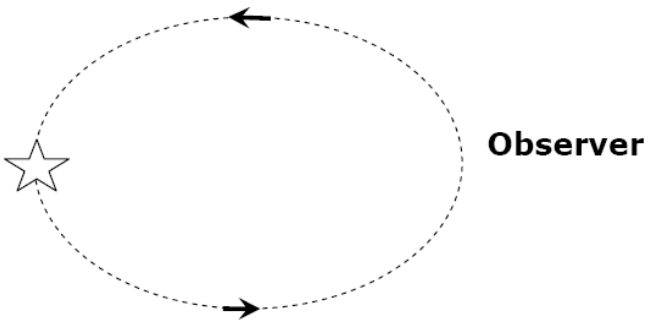


Interference - _____

Polarization - _____



Doppler Effect - _____



Electromagnetic Radiation - Wavelength and Frequency

- waves of energy generated by the _____

Why can't _____make this kind of wave?

- Have no _____

Travel at the _____in a vacuum

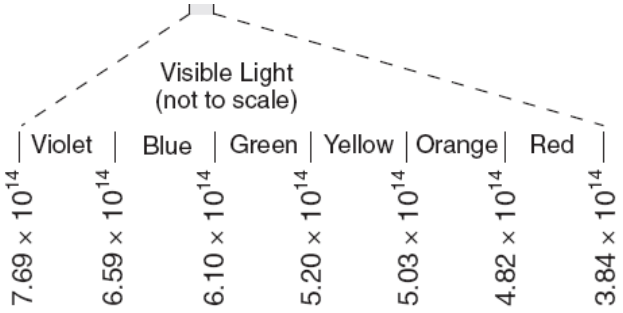
See Reference Table

Which one has the smallest wavelength? (hint: most penetrating)

Which one has the smallest frequency? (hint: how are wavelength and frequency related?)

Which color has the greatest wavelength? _____smallest? _____

Ex) Which color of light has a frequency of 6.0×10^{14} Hz?



_____

Ex) What is the frequency of light whose wavelength is 6×10^{-7} m?

v = _____ What color? _____