

OPTICS 1

Name _____

Part A: Reflection and Refraction

Medium

The material that a wave moves through.

Boundary

The end of a medium.

Reflection

When a wave strikes a boundary and *bounces off* of it.

Refraction

When a wave passes through a boundary (from one medium into another) and *bends* as it does.

REAL LIFE EXAMPLES

Slinky wave reflection	If you watch, you will see slinky waves always reflect when they reach the end of the slinky.
Light Reflection	A mirror Seeing your face in water Glare RADAR
Sound Reflection	Echo heard in a large cave or room Echolocation (animals using reflected sound waves to know what is in front of them) Reverberation (sound waves reflect within a room)
Light Refraction	A straw in a cup of water appears to be broken A magnifying glass causes light from one point (the focus) to spread out Glasses cause light to strike our fovea correctly. Objects on the other side of hot air appear distorted ("heat waves")

OPTICS 1

Name _____

Explanations:

Explain what effect causes the following effects:

Answer Bank (answers repeat)

- Slinky wave reflection
- Light wave reflection
- Sound wave reflection
- Light wave refraction

A.1 When I scream out in a large cave, I hear my voice back at me.

A.2 A straw in a cup of water appears to be broken.

A.3 You see your reflection in a mirror

A.4 Bats can catch insects by creating sound waves and hearing the response.

A.5 Light is bent as it moves between hot and cold air.

A.6 You see glare from the sun on a glass window.

A.7 After the sun is set, sunlight entering the atmosphere bends down and the sun still appears visible for another two minutes.

A.8 When I make a longitudinal wave in a slinky, it moves to the other end of the slinky then moves back to me.

A.9 It's a bright, sunny day after a major snowstorm. Your eyes hurt from the brightness.

A.10 When looking underneath a pool, everything appears distorted.

Par B: Using Wave Reflection for Seeing or Imaging**Echolocation**

An animal (a dolphin, whale, or bat) creates an ultrasonic wave. If the wave strikes something ahead of the animal, it reflects backward and the animal “hears” what is in front of it.

Echolocation uses *ultrasonic waves* (with a higher frequency than we can hear).

SONAR

A technology used by submarines that mimics echolocation.

The submarine produces a ultrasonic wave and then has sensors to detect if it is reflected.

RADAR

A technology that mimics echolocation, but instead of using sound waves, uses *radio waves*, which are a type of electromagnetic wave.

For example, radiowaves are fired up into the air. If there is a plane, they reflect off that plane and return to the sensor.

Ultrasonic Imaging

A medical device that mimics echolocation to see within human bodies.

Ultrasonic waves are created inside of your body. They reflect off of anything inside of your body (bones, ligaments, a tumor, a fetus), and create an image you can use to detect if you are healthy.

Part C: The Law of Reflection

Incident Ray:

A ray of light that hits a mirror.

Normal Line

A line perpendicular to the mirror.

Angle of Incidence:

Angle between the incident ray and normal line.

Reflected Ray:

A ray reflected off the mirror.

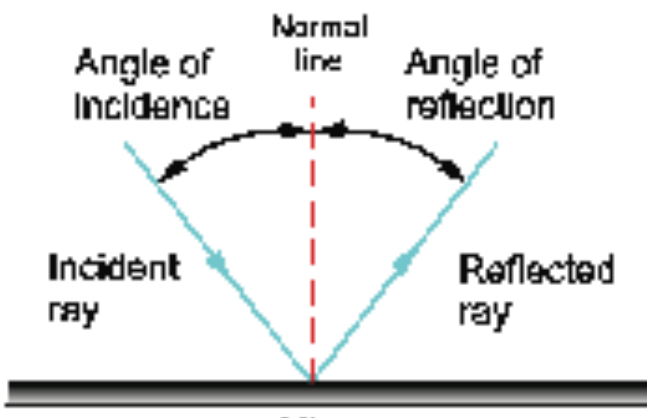
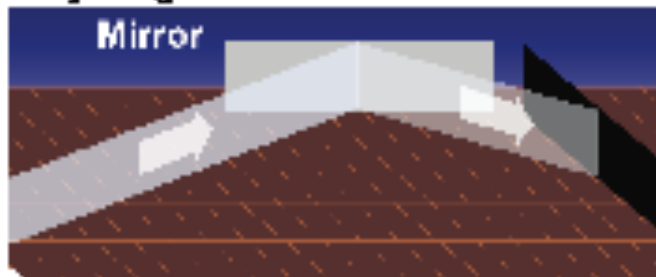
Angle of reflection

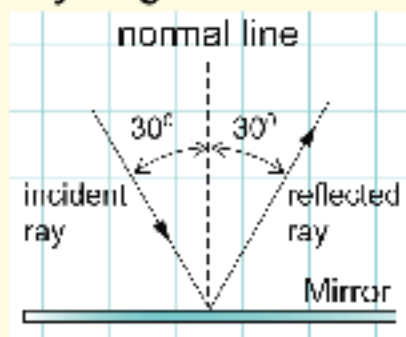
Angle between the reflected ray and normal line.

Law of Reflection:

The angle of incidence equals the angle of reflection.

Ray diagram



Ray diagram

In this picture,
What is the angle of incidence?

What is the angle of reflection?

Are they equal?

Which LAW OF PHYSICS tells you they must be equal?

Fill in the Blank

A line perpendicular to the mirror is called the _____.

The ray of light that hits a mirror is the _____.

The ray of light that bounces off a mirror is called the _____.

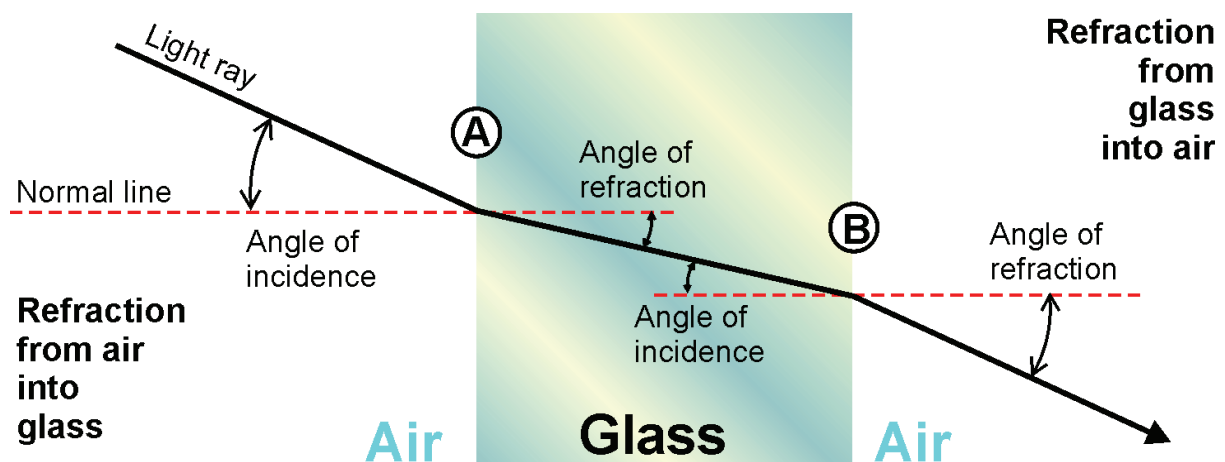
The angle of incidence always _____ the angle of reflection!

How does understanding the LAW OF REFLECTION help you become a better pool player?

Draw your own RAY DIAGRAM. Label the *incident ray*, *reflected ray*, *angle of incidence*, and *angle of reflection*.

Part D: Pictures of refraction

Boundary
Where two different mediums meet.
Incident Ray
The ray of light that hits the boundary.
Refracted Ray
The ray of light that goes through a boundary and <i>bends</i> .
Normal Line
A line perpendicular to the boundary.
Angle of Incidence
Angle between the incident ray and the normal line.
Angle of Refraction
Angle between the refracted ray and the normal line.



Light moves FASTER
When light moves FASTER in the second medium, the refracted ray bends AWAY FROM the normal line.
Light moves SLOWER
When light moves SLOWER in the second medium, the refracted ray bends TOWARDS the normal line.

OPTICS 1

Name _____

Fill in the Blank

In physics, a line perpendicular to a surface is the _____ line.

A ray of light that hits a boundary is called an _____.

A ray of light that has just bent is called the _____.

The angle between the incident ray and the normal line is the _____.

The angle between the refracted ray and the normal line is the _____.

If light *slows down* at a boundary, the light ray bends _____ the normal line.

If light *speeds up* at a boundary, the light ray bends _____ the normal line.

Pictures

Light moves from AIR to WATER. Does light speed up or slow down?

Draw a picture of refraction as light moves from AIR to WATER. Label the *normal line*, *incident ray*, *refracted ray*, *angle of incidence*, and *angle of refraction*.

Light moves from WATER to AIR. Does light speed up or slow down?

Draw a picture of refraction as light moves from WATER to AIR. Label the *normal line*, *incident ray*, *refracted ray*, *angle of incidence*, and *angle of refraction*.

What is the difference between your two drawings? Which angle changes?

OPTICS 1

Name _____

Part F: Index of Refraction Formula

Medium:

The matter that a light wave moves through.
Light can move through a medium or a vacuum

Index of refraction

Light moves fastest through a vacuum, and slows down when it moves through a medium.
(However, it still goes very fast.)

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

Symbol	Quantity	SI UNIT
v	Speed of light in medium	m/s
c	Speed of light in vacuum: 3.0×10^8 m/s	m/s
n	Index of refraction of the medium	Unitless

Medium	Index of Refraction
Vacuum	1.0
Water	1.33
Ice	1.31
Glass	1.5
Diamond	2.42

How fast does light move through water?

Looking For	
Already Know	
Formula	Answer in a complete sentence <i>with unit</i> :

How fast does light move through glass?

Looking For	
Already Know	
Formula	Answer in a complete sentence <i>with unit</i> :

OPTICS 1

Name _____

How fast does light move through a diamond?

Looking For	
Already Know	
Formula	Answer in a complete sentence <i>with unit</i> :

Through what medium does light travel *fastest*?

Through what medium does light travel *slowest*?

Part G: Why refraction happens:

Refraction
Refraction is when light bends as it moves between two mediums
Why does refraction occur?
Refraction happens because light changes speed as it moves between two mediums.

True or False?

Light moves the same speed in every medium.

Light typically moves straight from one medium to another.

Light bends as it changes mediums.

Light bends because it changes speed.

Light moves fastest through diamond.

Refraction occurs because light changes speed as it moves between mediums.

Why does refraction happen?

What are some real life examples of refraction?

OPTICS 1

Name _____

What I want to do here:

- what are reflection and refraction (focus on those two to start)
- identifying specific real world examples
- articles on specific real world examples, questions on said articles
- precise diagrams of reflection and refraction
-

[where does diffraction come in???

[specific examples:

reflection used as a means of *seeing*: echolocation, sonar, radar, ultrasound imaging]

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[I need to create my own diagrams of reflection and refraction using html canvas]

A more advanced question I need to add:

- does light bend in or out when it moves from glass to water

I need to start a Refraction 2 and Refraction 3 packet with these concepts:

---- does light bend in or out when it moves between glass and water
(this should be at the *end* of the first refraction packet)

--- drawing a light as it moves from a fish in an aquarium to a human, and from the human to the fish

----- snell's law

---- and relating snell's law to

---- why refraction occurs (bent-hur)

--- prism rainbows