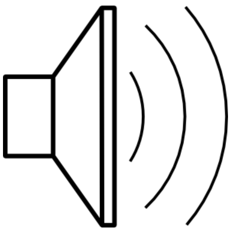
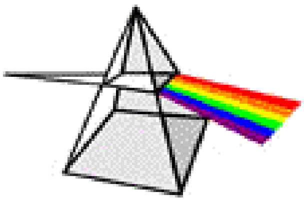
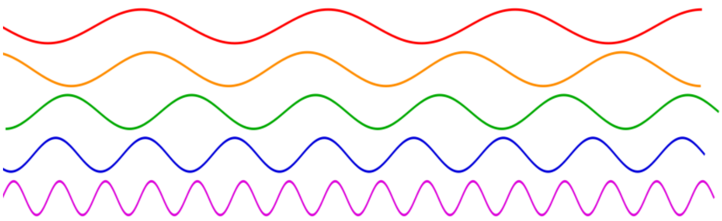
# Wallace Hall Academy

## Physics Department
## S2

## Waves Notes Booklet







Name: ______________________________

# Wave Characteristics

Waves transfer (move) energy from one place to another.

There are many ways to describe the different parts of a wave.
We call these different parts "wave characteristics".

Key Wave Characteristics

Amplitude:

Axis:

Peak:

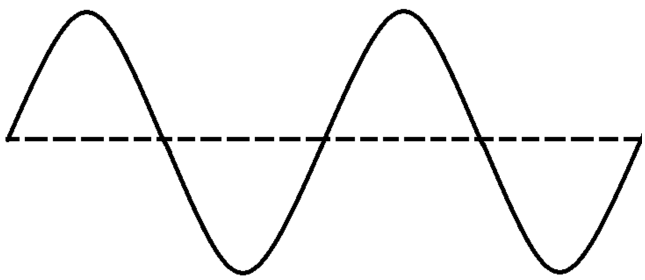
Trough:

Wavelength:

Frequency:

Speed:

On the diagram **accurately** label the peak, trough, axis, amplitude and wavelength.



# Wave Characteristics: Speed

In Maths you should have learnt about an equation which allows us to work out something's speed so long as we know the distance and the time.

Symbol form,

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

We can use this same equation to work out how fast a wave is going too.

Example

A girl is in her boat 40m away from the shore. She watches a wave pass the boat and reach the shore 8 seconds later. Calculate the speed of the wave.

Questions

1. A wave travels a distance of 35m in 14 seconds. Calculate its speed.

2. A wave is travelling at 3 m/s. Calculate the distance it has travelled after 10 seconds.

# Wave Characteristics: Frequency

Frequency is a measure of how often something happens. The frequency for waves is how many waves pass a point every second. So 1 wave per second would be a very low frequency and 1000 waves per second would be a very high frequency. Can you imagine being at the seaside and 1000 waves hit you every second?!

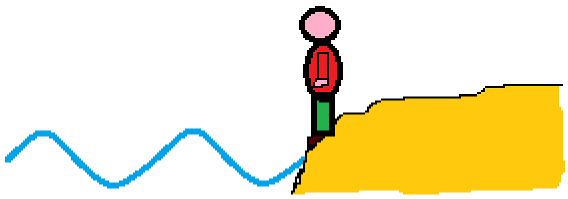
There is another equation we use to measure the frequency of waves.

Symbol form,

$$\text{frequency} = \frac{\text{number of waves}}{\text{time}}$$

Example

A boy on the beach counts the number of waves hitting the shore for 20 seconds. He counts 30 waves altogether. Calculate the frequency of the waves.



Questions

1. 10 waves hit off the side of a pier in 40 seconds. Calculate the frequency of the waves.

2. 12 waves crash into the side of a boat over a time of 2 minutes. Calculate the frequency of the waves.

# Wave Characteristics: The Wave Equation

There is another way to work out the speed of waves but by using their "frequency" and "wavelength".

We can figure it out by comparing it to someone walking. Say you took 3 steps in one second and the length of each step was 2m, then you would have travelled a distance of 6 metres in one second (6 m/s). The 3 steps per second would be your "frequency" and the 2m length of each step would be your "step-length". If you maintained this frequency and step-length you would be travelling at 6 m/s. We get your speed by multiplying your frequency by your step-length.

It is the same for waves but we get their speed by multiplying their frequency by their wavelength.

Symbol form,

| speed = frequency x wavelength | |
|---|---|

The symbol λ ("lambda") is part of the Greek alphabet and we use it to symbolise wavelength.

<u>Example</u>

A wave has a frequency of 10 waves per second and a wavelength of 7m. Calculate the speed of the waves.

# Wave Characteristics: The Wave Equation

Questions

1. A wave has a wavelength of 12m and a frequency of 4 waves per second. Calculate the speed of the waves.

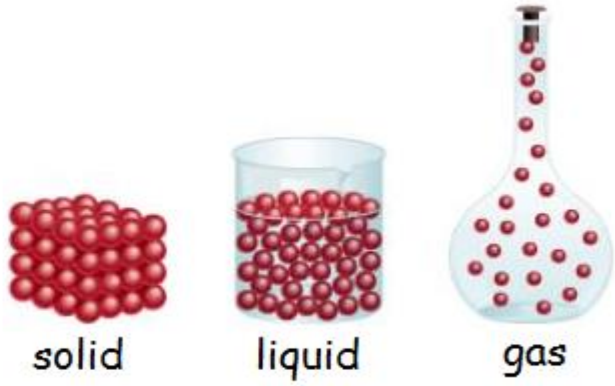
2. A sailor watches waves passing his boat. He counts the frequency of the waves to be 3 w/s and the wavelength to be 3m. Calculate the speed of the waves.

3. Waves are travelling at 4 m/s and have a frequency of 8 w/s. Calculate the wavelength of the waves.

4. Tsunamis are travelling across the Indian Ocean at a speed of 500 m/s. The wavelength of the tsunamis is 0.2km. Calculate the frequency of the tsunamis.

# Sound Waves: How does sound travel?

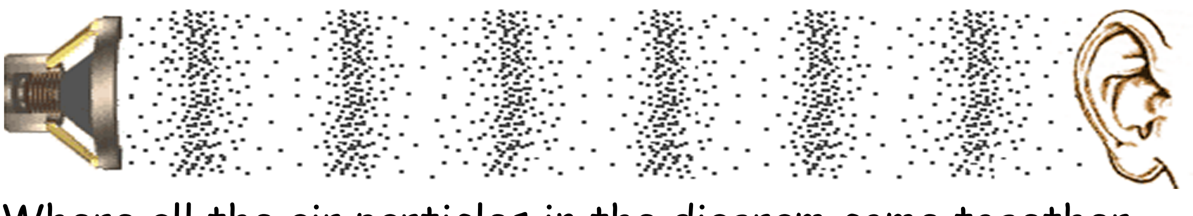
All solids, liquids and gases are made up of particles.




Anything that has particles is called a medium. The plural of medium is media, so if I had a glass of water I would have two media (glass and water).

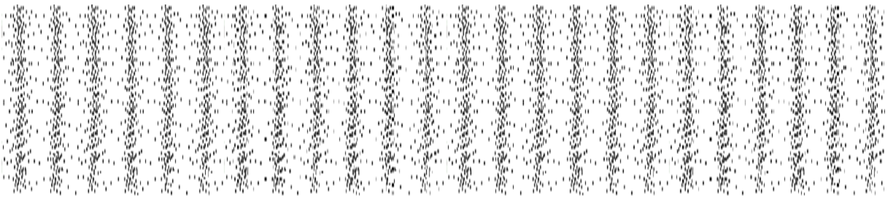
Anything that does not have any particles is called a vacuum. Outer space is the best known vacuum but we can create vacuum chambers on Earth by pumping all the air out of an enclosed container.

Sound waves are produced when particles vibrate, bumping in to one another, letting the wave travel.

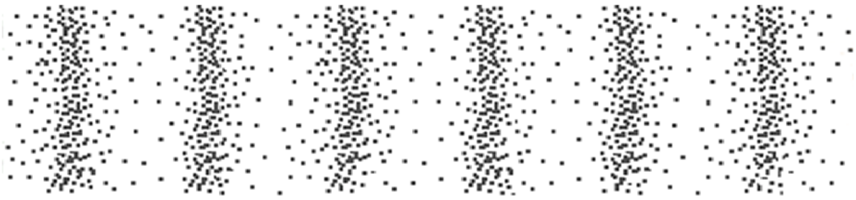


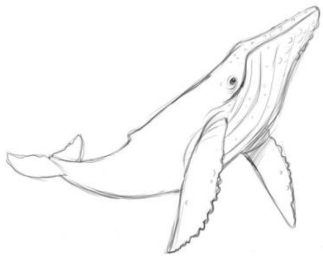
Where all the air particles in the diagram come together (compress) then this is the peak of sound waves. Where they are most spread apart is the trough of the sound waves.

# Sound Waves: How does sound travel?



If the sound waves have a high frequency (many waves per second) like in the diagram above, then we say the sound would be very high pitched. Dolphins use very high pitched sounds to communicate.





If the sound waves have a low frequency (few waves per second), then we say the sound would be very low pitched. Blue Whales use very low pitched sounds to communicate.

## What can sound waves travel through?

Particles need to vibrate so sound waves can travel. This means any solid, liquid or gas (any medium) will allow sound waves to travel through.

Vacuums have no particles so it is impossible for sound waves to travel through them. This is why astronauts need radios in their suits so they can talk to each other in space.

# Sound Waves: How Fast Do They Travel?

## Aim

The aim of my experiment is

## Diagram

## Method

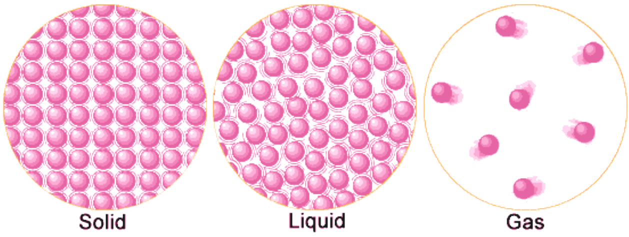
## Results

| Distance (m) | Time 1 (s) | Time 2 (s) | Time 3 (s) | Av. Time (s) | Speed (m/s) |
|---|---|---|---|---|---|
| | | | | | |

## Conclusion

The value we got was
The real value
Ways we could get better results are

# <u>Sound Waves: How Fast Do They Travel?</u>




Sound waves travel at different speeds through different media (solids, liquids and gases). The closer together particles are in a medium the faster they bump into each other when they are vibrating. This means sound waves actually travels fast through solids and liquids but slower through gases (like the air).

| **Medium** | **Speed of Sound (m/s)** |
|---|---|
| Aluminium | |
| | 340 |
| Carbon Dioxide | |
| | 1500 |

<u>Questions</u>

1. A killer whale has lost her pod in the ocean so calls out to try and find them. The pod hears her call 3 seconds after she makes the sound. Calculate how far away the pod must be.

2. A man shouts to his friend who is across a field 170m away. Calculate the time it takes the sound waves to reach the man's friend.

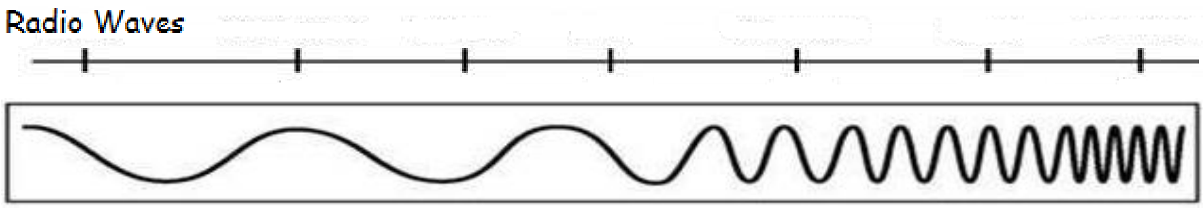
# <u>Electromagnetic Waves: The Electromagnetic Spectrum</u>

A "spectrum" is a way of showing something on a scale between extreme points.

For example, a temperature spectrum would show things between extremely hot and extremely cold...

HOT COLD

The Electromagnetic Spectrum compares different electromagnetic waves. One side of the spectrum has very large wavelengths and the other side has very small wavelengths.




LONG λ SHORT λ

Radio waves have the largest wavelength. From the song see if you can remember the order that the EM waves came in for the spectrum, then write them in on the above diagram.

All electromagnetic waves travel at 300, 000, 000 m/s through the air and through space.

# Electromagnetic Waves: Research

- Your teacher will give you an EM radiation
- Research your given EM radiation
- Create a PowerPoint on your findings

PowerPoint - MUST include

- Title page
- Background Information
- Uses
- Dangers
- Lots of Pictures!

PowerPoint - MAY include

- Quiz
- Short Video (3 mins max.)

**Prize for best presentation**

# Electromagnetic Waves: Types and Uses

| **Type of Radiation** | **Uses** | **Method of Detection** | **Additional Info (at least one)** |
|---|---|---|---|
| Radio Waves | | | |
| Microwaves | | | |
| Infrared | | | |
| Visible Light | | | |
| Ultraviolet | | | |
| X-rays | | | |
| Gamma Rays | | | |

| | | | |
|---|---|---|---|

# Visible Light: What is white light?

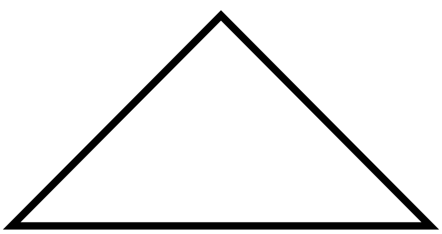
## Aim

The aim of my experiment is

## Method

## Diagram

## Results



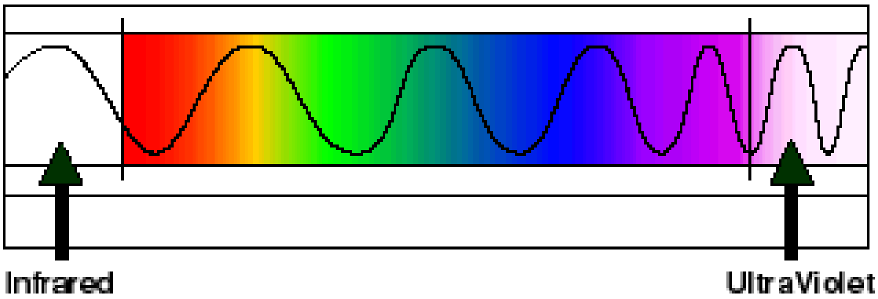
## Conclusion

From my results I discovered that

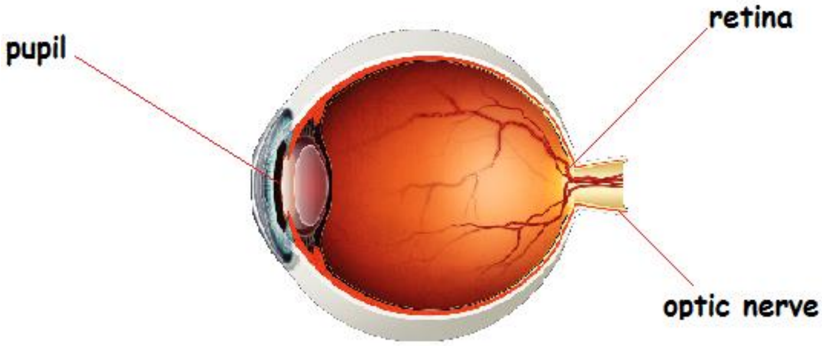
## Visible Light: Light and the Brain

In the previous experiment we seen there was an order that visible light comes in. The reason there is an order is because there are different wavelengths of visible light.

Our eyes pick up the different wavelengths of visible light and our brains interpret them as different colours. Red has the largest wavelength and violet has the shortest wavelength.

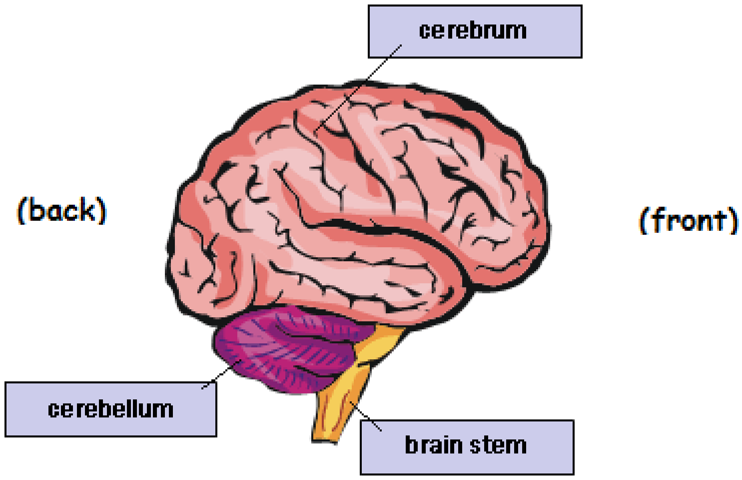



When light reaches your eye it passes through the pupil (black part) and should focus at the retina (back of your eyeball). Connected to your retina is the optic nerve which connects your eyeball to your brain.



# Visible Light: Light and the Brain

There are three main parts that make up the brain called the cerebrum, the cerebellum and the brain stem (medulla).




1. The **cerebrum** fills up most of your skull. It is involved in remembering, problem solving, thinking, and feeling. It also controls movement.

2. The **cerebellum** sits at the back of your head, under the cerebrum. It controls coordination and balance.

3. The **brain stem (medulla)** sits beneath your cerebrum in front of your cerebellum. It connects the brain to the spinal cord and controls automatic functions such as breathing, digestion, heart rate and blood pressure.

It is at the back of the cerebrum, just above the cerebellum, that light entering our eye is processed. Due to the way our eyes focus the light everything should appear upside down, but our brain actually flips it the right way around.

# Visible Light: Light and Space

In our solar system is a star that we call the Sun. Orbiting the Sun are 8 planets. Even though light from the Sun travels at 300, 000, 000 m/s it still takes quite a lot of time to reach all the different planets. This is because the distances between the planets and the Sun are huge!

Due to the huge distances, scientists are faced with it is often a lot easier to scale things down.

| Planet | Real Distance from Sun (m) | Scaled Distance from Sun (m) |
|---|---|---|
| Mercury | 58, 000, 000, 000 | |
| Venus | 108, 000, 000, 000 | |
| Earth | 150, 000, 000, 000 | |
| Mars | 228, 000, 000, 000 | |
| Jupiter | 779, 000, 000, 000 | |
| Saturn | 1, 430, 000, 000, 000 | |
| Uranus | 2, 880, 000, 000, 000 | |
| Neptune | 4, 500, 000, 000, 000 | |

Questions

1. Calculate how long it takes for light from the Sun to reach Earth.

2. Calculate how long it takes for light from the Sun to reach Neptune.

# Reflection: The Law of Reflection

## Aim

The aim of my experiment is

## Method

## Diagram

## Results

| Incoming Angle | Reflected Angle |
|---|---|
| | |
| | |
| | |

## Conclusion

# Refraction: Bending Light

## Aim

The aim of my experiment is

## Method

## Diagram

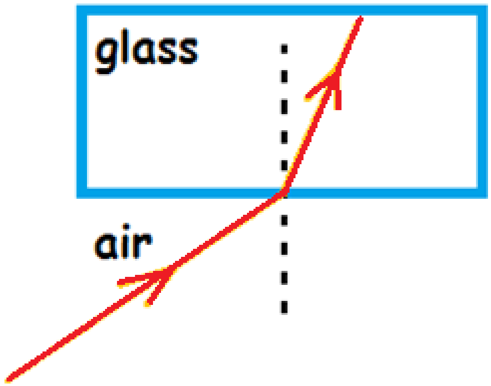
## Results

| Incoming Angle | Refracted Angle |
|---|---|
| | |
| | |
| | |

## Conclusion

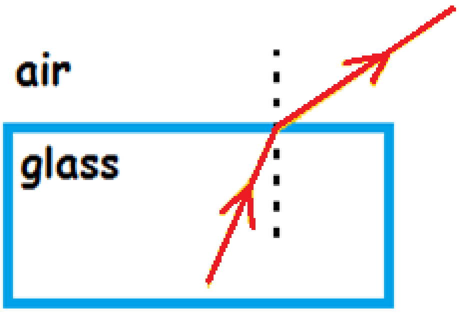
# Refraction: Bending Light

When light passes from a less dense medium (like the air) to a denser medium (like glass) the light slows down.




If the light enters a denser medium from a less dense medium at an angle, the light will bend towards the normal.

When light passes from a denser medium (like glass) to a less dense medium (like air) the light speeds up.

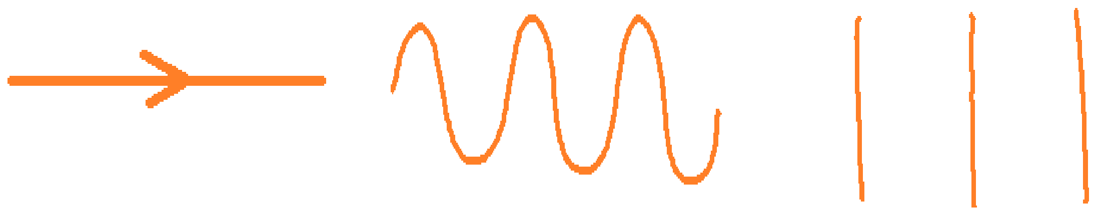



If the light exits a denser medium to a less dense medium at an angle, the light will bend away from the normal.

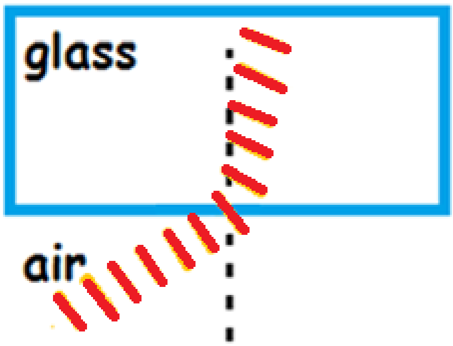
# Refraction: Bending Light

It is easier to understand why the light bends in a particular direction by first considering the different ways we can draw a wave.

Ray | Side-on View | Top View

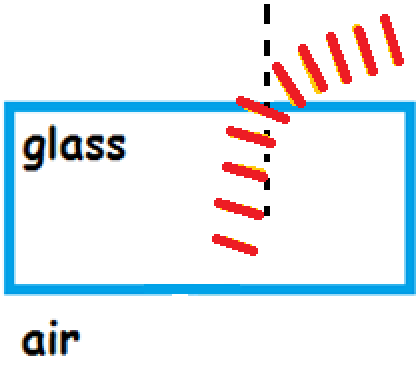


If we draw a top view diagram for refraction then we see that one side of the waves enter the glass block first, so this side is slowed down first, causing the rest of the wave to be twisted towards that side until the whole wave is inside the glass block.

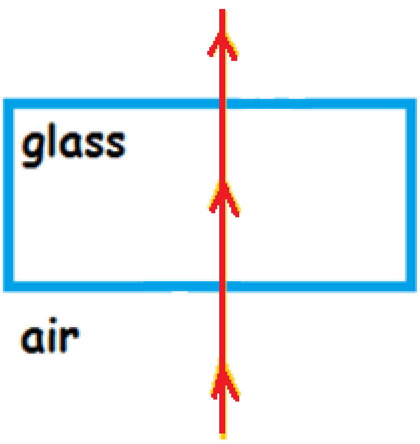


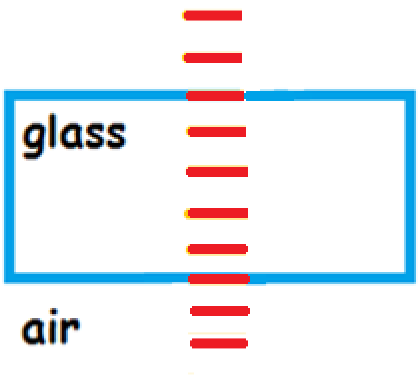
# Refraction: Bending Light

When the light is exiting the glass block at an angle then one of the sides leaves the glass first, meaning the other side is still going slow. The slow side pulls the rest of the light round meaning it bends away from the normal, until the whole wave has left the glass block.




If light enters the glass block straight on then it does not bend (refract) as both sides of the light slow down at the same time. This means the light still slows down but will not be twisted one way or another.



# Total Internal Reflection: The Critical Angle

## Aim

The aim of my experiment is to

## Method

## Diagram

## Results

| Incoming Angle | Refracted Angle |
|---|---|
| 20° | |
| | 90° |
| | Light totally internally reflected |

## Conclusion

The critical angle was ___. *The critical angle is the value of the incoming angle when the light refracts at 90°*. When the incoming angle is _____ _____ the critical angle the light refracts out the other side. When the incoming angle is ____ _____ the critical angle the light totally internally reflects.

# Total Internal Reflection: The Critical Angle

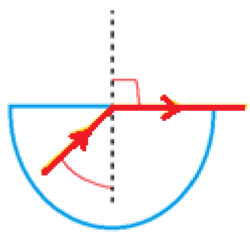
Total internal reflection occurs when light inside of a dense medium like glass or water cannot refract out to a less dense medium like the air. Instead the light hits the surface between the two media and all of the light reflects, staying inside the dense medium.

Whether light refracts out or totally internally reflects depends on the incoming angle that light hits the surface.

There is a term called the critical angle which is the incoming angle at which light refracts at 90°, along the edge of the surface.

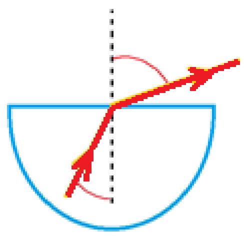
## Critical Angle

- Incoming Ray = Critical Angle
- Light refracts at 90°



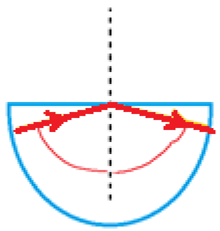
## Less than the Critical Angle

- Incoming Ray < Critical Angle
- Light refracts out other side.



## More than the Critical Angle

- Incoming Ray > Critical Angle
- Light totally internally reflects



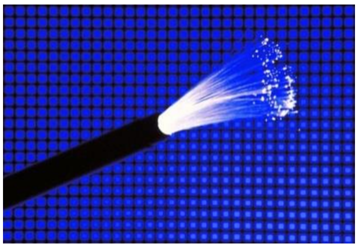
# Total Internal Reflection: Uses

Endoscopes (for checking health)

Endoscopes (for security)

Fibre optics (for decorations)

Fibre optics (for communication)



# Lenses: How do they affect light?

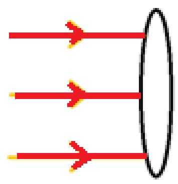
## Aim

The aim of my experiment is

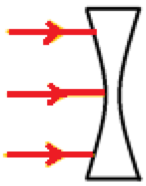
## Method

## Diagram

## Results



_______ lens



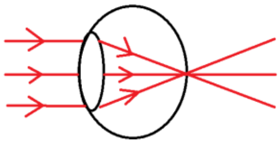
________ lens

## Conclusion

# Lenses: Eye Defects

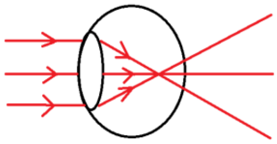
## Normal Eye-Sight

Most people have good eye-sight which means that they see everything around them clearly. This is because light entering their eye comes to a focus at the back of their eye. In other words, the light reaches a focal point at the retina.



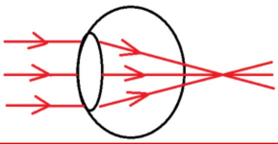
## Short-sighted

For some people though they can only see images up close clearly. We say they are short-sighted and this is because light entering their eye comes to a focal point "short" of the retina, so things appear blurry.



## Long-sighted

For other people they can only see images clearly far away. We say they are long-sighted and this is due to light entering their eye coming to a focal point "long" of the retina, making things appear blurry too.

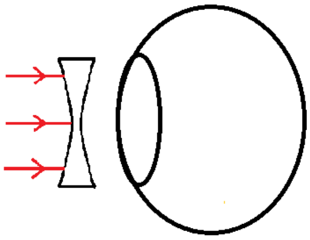


# Lenses: Correcting Eye Defects

Eye defects can be corrected by using an appropriate type of lens.

For people that are short-sighted we need to spread the light coming towards the eye out first. This is so when it does reach the eye and starts to become focused it will now be focused further back (at the retina) so images appear clearly.

A _______ lens spreads the light outwards before it reaches the eyeball. This means it will focus further back in the eye.



For people that are long-sighted we need to start to focus the light coming towards the eye first. This is so when it reaches the eye and starts to become even more focused it will now be focused sooner (at the retina) so images will appear clearly.

A ________ lens brings the light inwards before it reaches the eyeball. This means it will focus sooner in the eye.