



# Waves and Optics

# Waves

- A **wave** is a **disturbance** which travels through a vacuum or medium (air, water, etc) that contains matter
- A wave transports **ENERGY not matter**

# Waves

- Some waves do not need a medium to travel in; they can travel even in the absences of particles (vacuum)
  - Example: light, x-rays, gamma rays
- Other waves do need a medium to travel; they depend on the particles hitting each other
  - Example: sound waves

# *Physics of Light*



# Light

- What is it?

- An electromagnetic wave that is visible to the naked eye

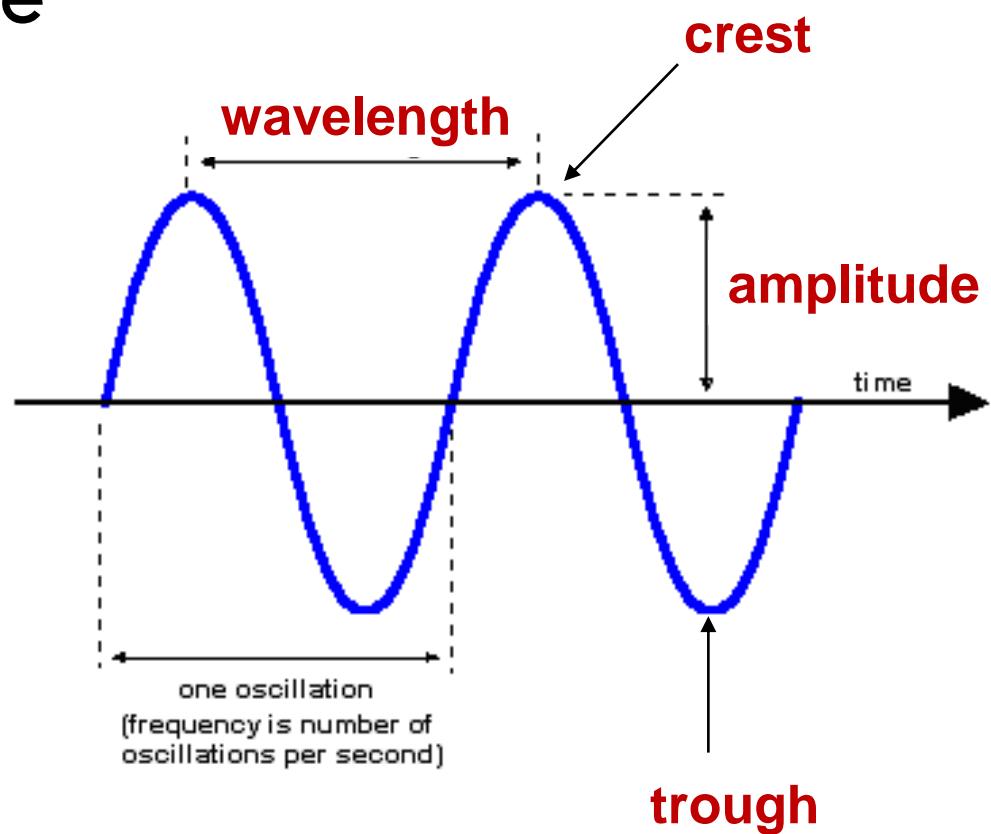
- Waves have 3

components:

- Amplitude

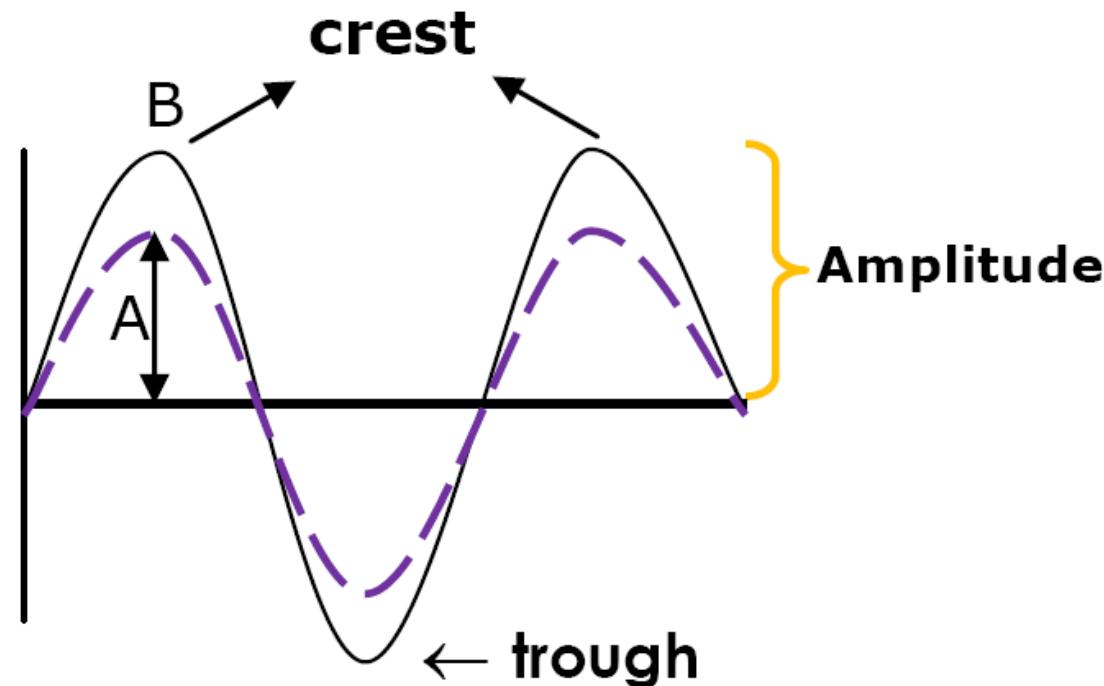
- Wavelength

- Frequency



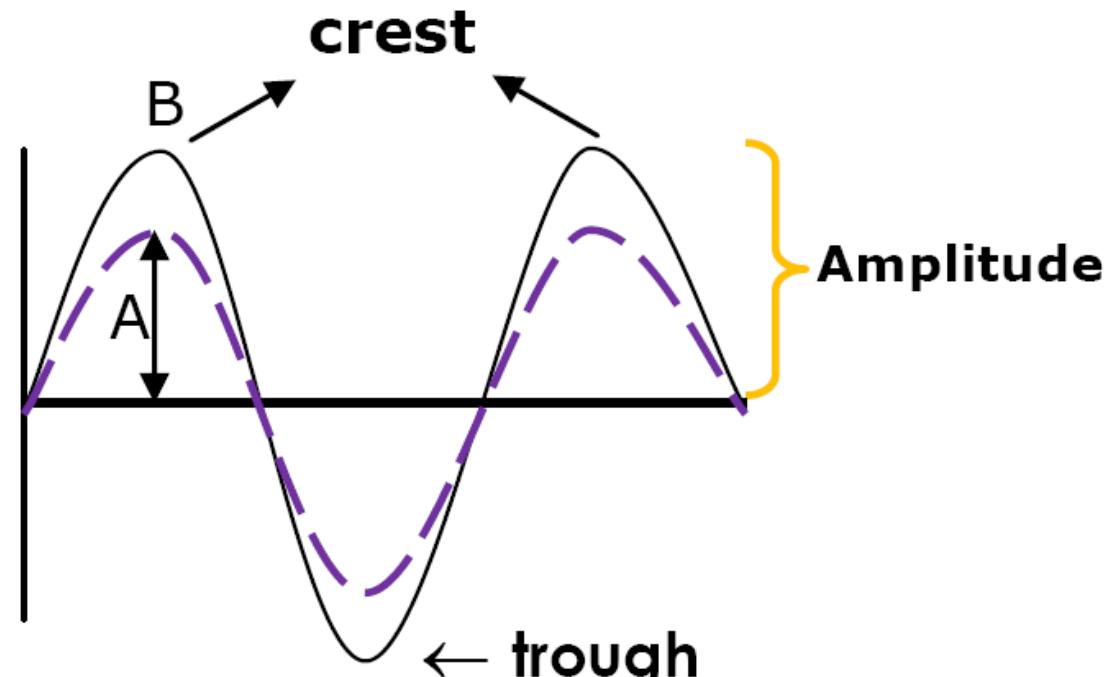
# Amplitude

- Amplitude is the maximum height from its resting position
- Amplitude is a wave's intensity
  - For light this means its brightness



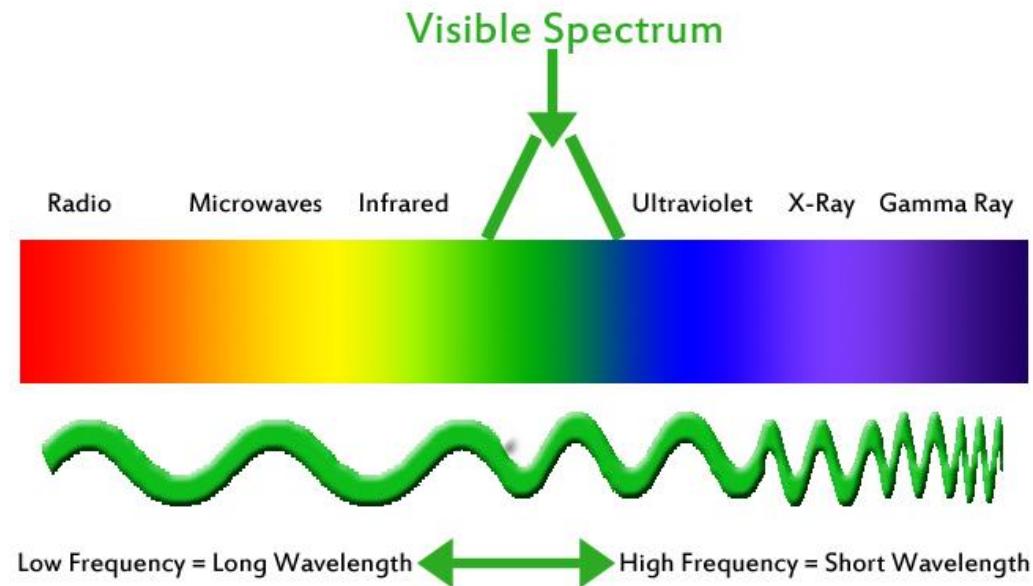
# Wavelength

- The wavelength of a wave is the distance between a point on one wave and the same point on the next wave, eg. crest to crest



# Wavelength

- For visible light: the wavelength will indicate its colour
  - Red has the longest wavelength
  - Violet has the shortest

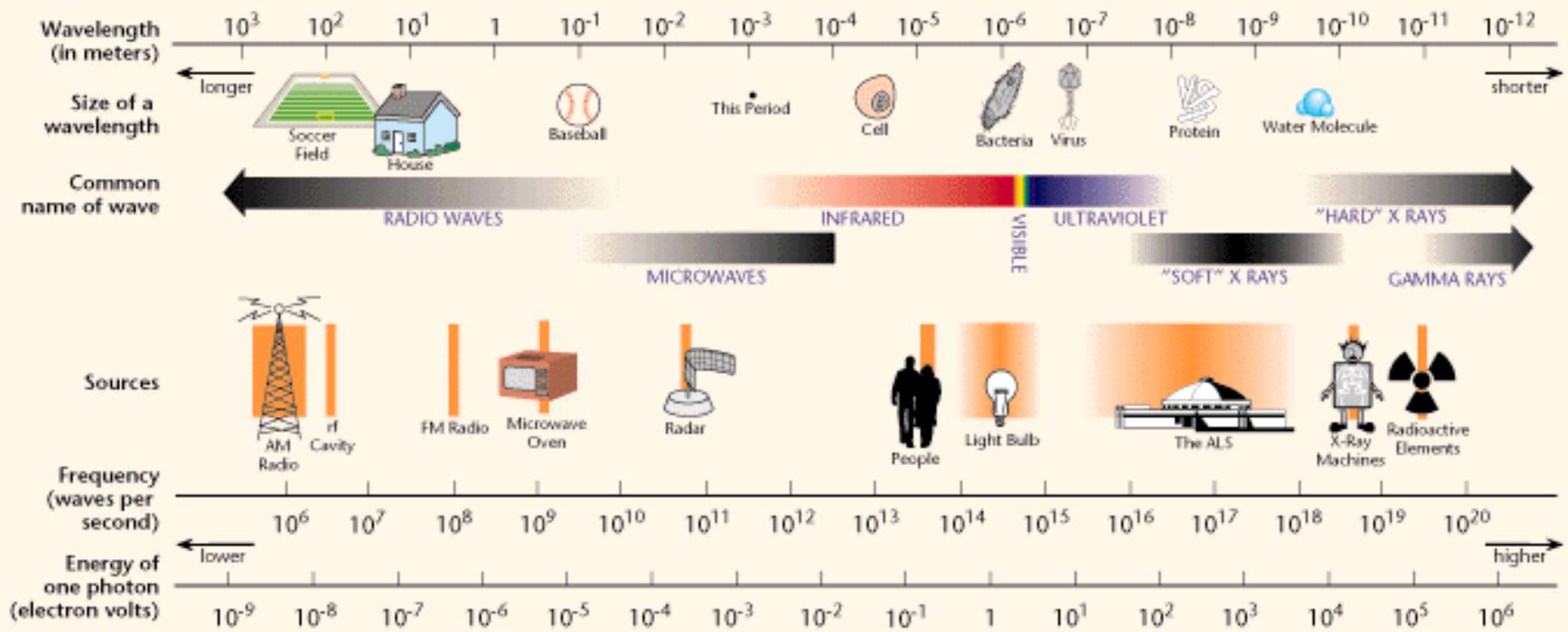


# Spectrum of light

- The colours we see are only a small part of the electromagnetic spectrum
  - We call this the **visible spectrum of light**
- Also have other types of waves that we cannot see
  - Example: **Radio waves, microwaves, heat waves, ultraviolet, x-rays, gamma rays**

# Spectrum of light

## THE ELECTROMAGNETIC SPECTRUM



<b>Types</b>	<b>Radio Waves</b>	
<b>Frequency</b>	<b>Lowest</b>	
<b>Energy</b>	<b>Lowest</b>	
<b>Tech Applications</b>	-Radio -TV -Microwaves	-Cell phones -MRI
<b>Interesting Facts</b>	Antennas are used, which connect the signals	

<b>Types</b>	<b>Infrared</b>
<b>Frequency</b>	<b>Higher</b>
<b>Energy</b>	<b>Higher</b>
<b>Tech Applications</b>	<ul style="list-style-type: none"><li>-Night Vision Goggles</li><li>-Wireless Keyboard</li><li>-Satellites</li></ul>
<b>Interesting Facts</b>	<ul style="list-style-type: none"><li>-Heat is emitted (given off)- “feels warm”</li><li>-Some animals use infrared to locate their prey</li></ul>

<b>Types</b>	<b>Visible Light</b>
<b>Frequency</b>	→
<b>Energy</b>	→
<b>Tech Applications</b>	<ul style="list-style-type: none"><li>-Laser</li><li>-microscopes</li><li>-computer screens</li></ul>
<b>Interesting Facts</b>	<ul style="list-style-type: none"><li>-Only wave length we can see</li><li>-Red = longest wave length of visible light</li><li>-Violet = shortest wave length of visible light</li><li>- When visible light hits water vapour = rainbow</li></ul>

<b>Types</b>	<b>UV Light</b>
<b>Frequency</b>	→
<b>Energy</b>	→
<b>Tech Applications</b>	<ul style="list-style-type: none"><li>-Sterilize Equipment</li><li>-Treatment for Jaundice</li></ul>
<b>Interesting Facts</b>	<ul style="list-style-type: none"><li>-Necessary for Vitamin D</li><li>-Causes Cancer</li><li>-Animals can sense them</li></ul>

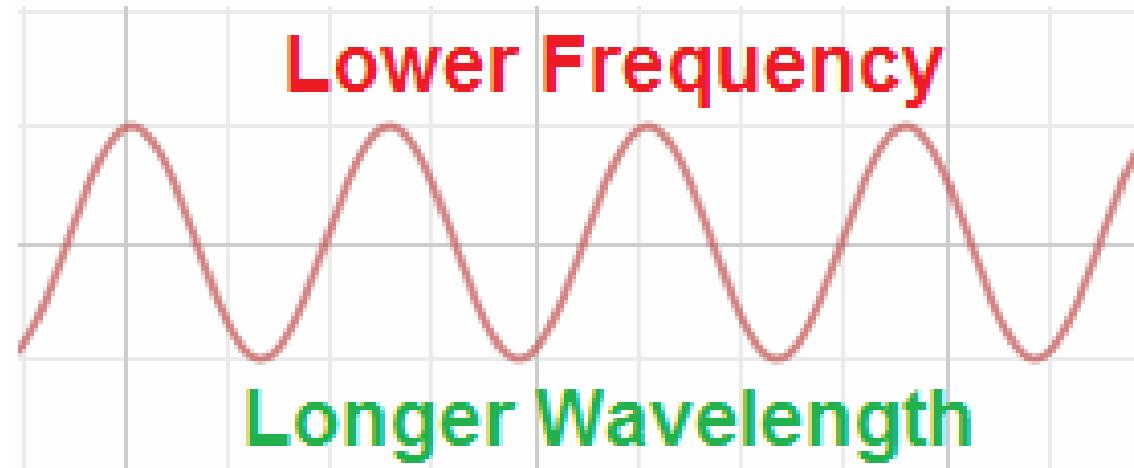
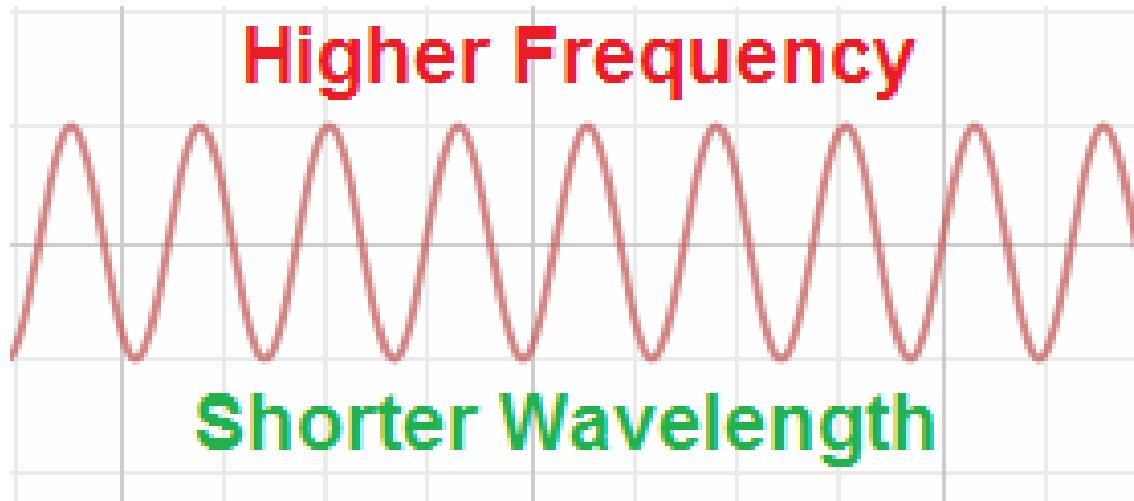
<b>Types</b>	<b>X-Rays</b>
<b>Frequency</b>	→
<b>Energy</b>	→
<b>Tech Applications</b>	<ul style="list-style-type: none"><li>-X-Rays</li><li>-Baggage and Body inspection at airport</li></ul>
<b>Interesting Facts</b>	<ul style="list-style-type: none"><li>-Too much can also cause cancer</li></ul>

<b>Types</b>	<b>Gamma Rays</b>
<b>Frequency</b>	<b>Highest</b>
<b>Energy</b>	<b>Highest</b>
<b>Tech Applications</b>	<ul style="list-style-type: none"><li>- Preserving food</li><li>-Cancer treatment</li></ul>
<b>Interesting Facts</b>	<ul style="list-style-type: none"><li>- Given a + or – charge for cancer treatments</li><li>-Kills microbes in food</li></ul>

# Frequency

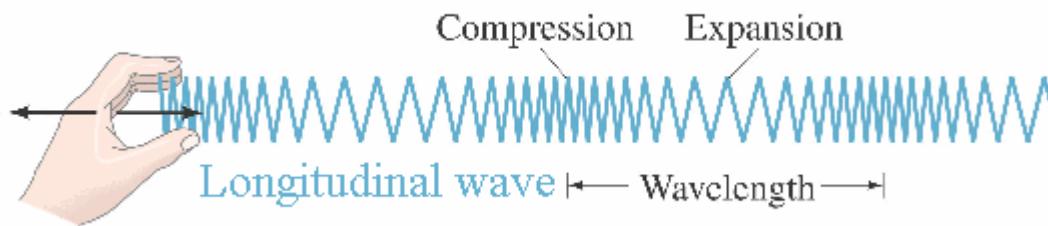
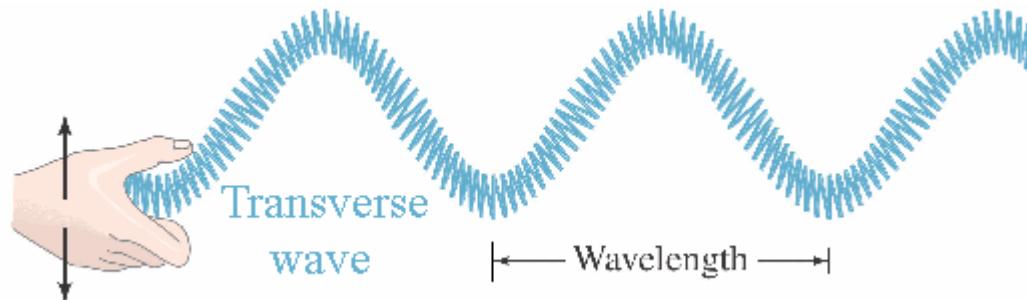
- Frequency is the number of waves per second
  - Measured in Hertz (Hz) = wavelengths/sec
- Note: wavelength and frequency are related
  - The shorter the wavelength, the higher the frequency
  - The longer the wavelength, the lower the frequency

# Frequency



# Two types of waves

## □ Transverse waves



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## □ Compression waves

# Transverse Waves

- Are moving waves that consists of oscillations occurring perpendicular (or right angled) to the direction of energy transfer
- Example: light

# Transverse Waves

- Because they are not made of vibrating particles they can travel through a vacuum. They **do not** need a **medium**. So they travel through space.
- They are very fast 300 000 000m/s in the air
  - Speed of light!

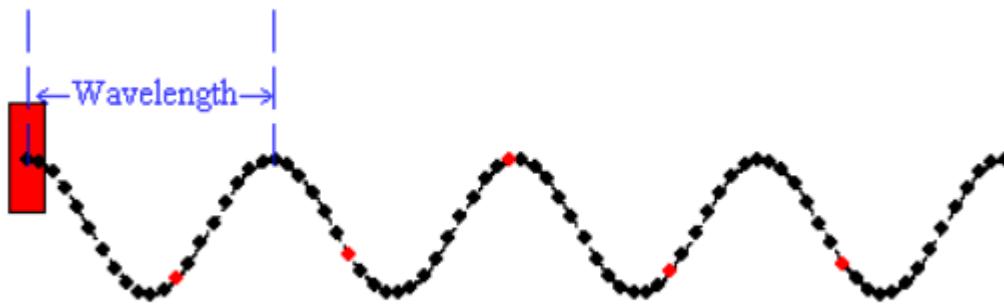
# Compression waves

- waves **compresses the medium**  
through which it is transmitted
  - Also called **longitudinal** waves
  - Example: **sound waves**
- Must travel through a **medium** (solid, liquid, gas)
  - No sound in space

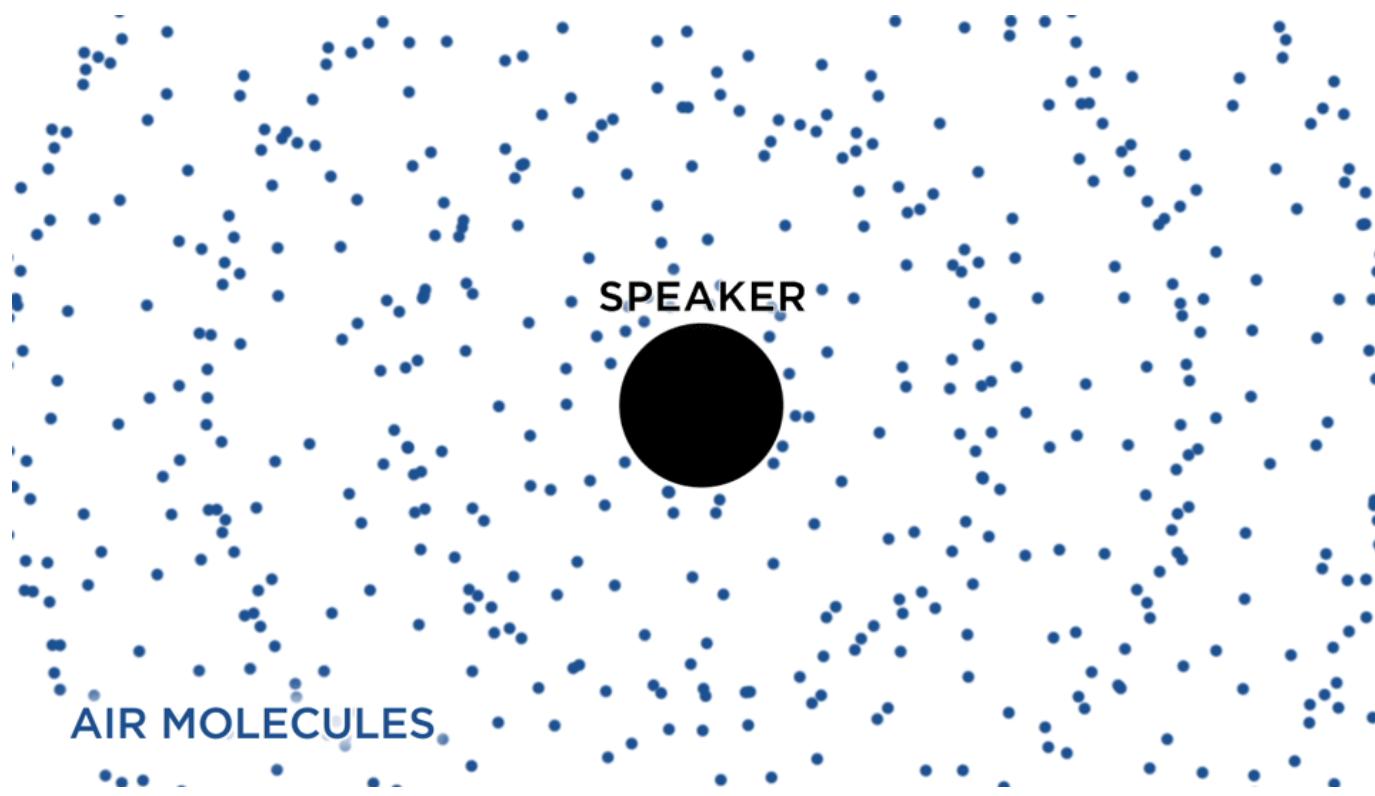
# Compression waves

- One molecule hits another molecule, which hits another one and so on
  - ▣ Passing on **energy**
- Since they depend on **collisions** they cannot move very fast
  - ▣ Less than 350 m/s in air

Transverse Wave



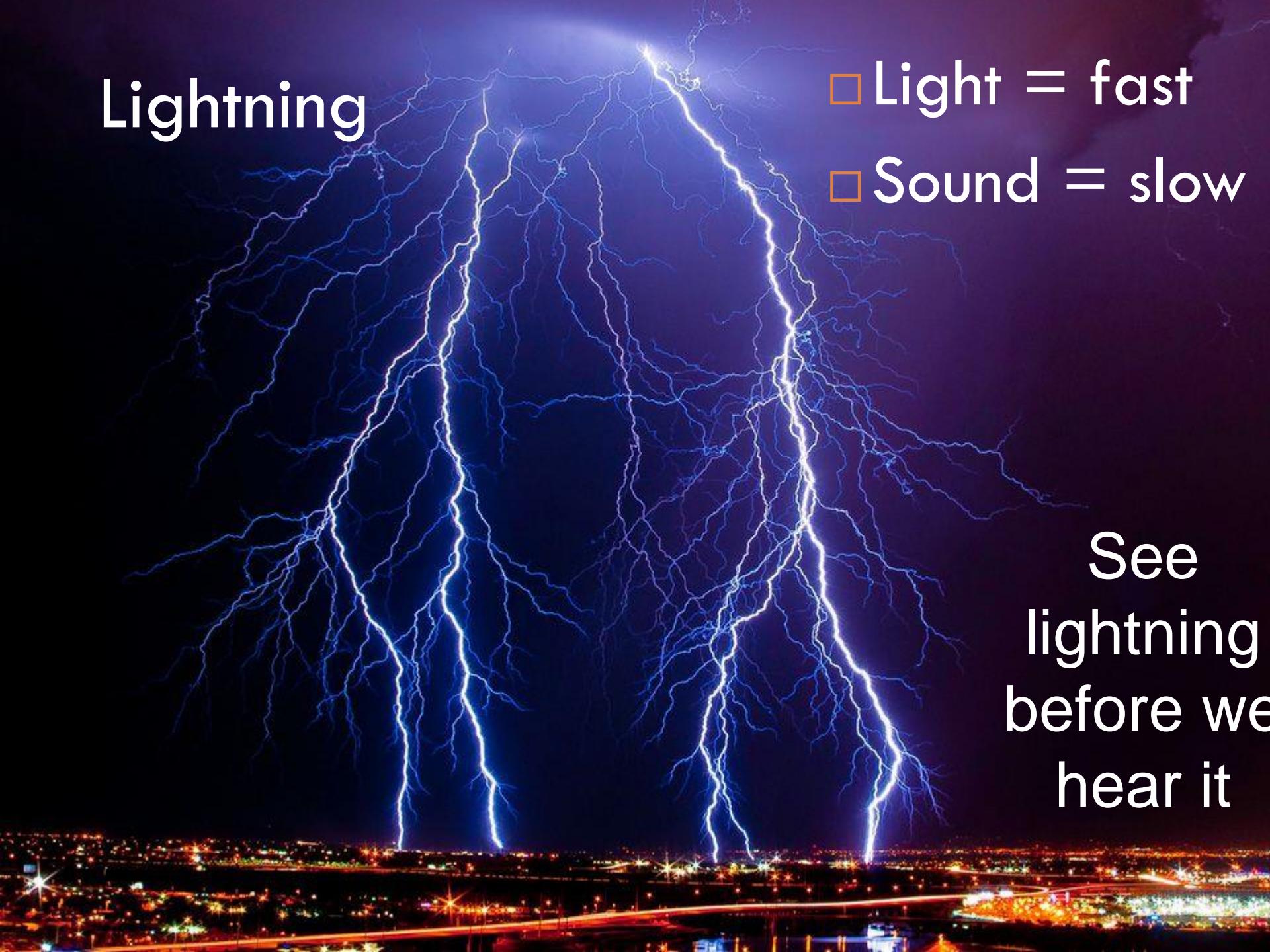
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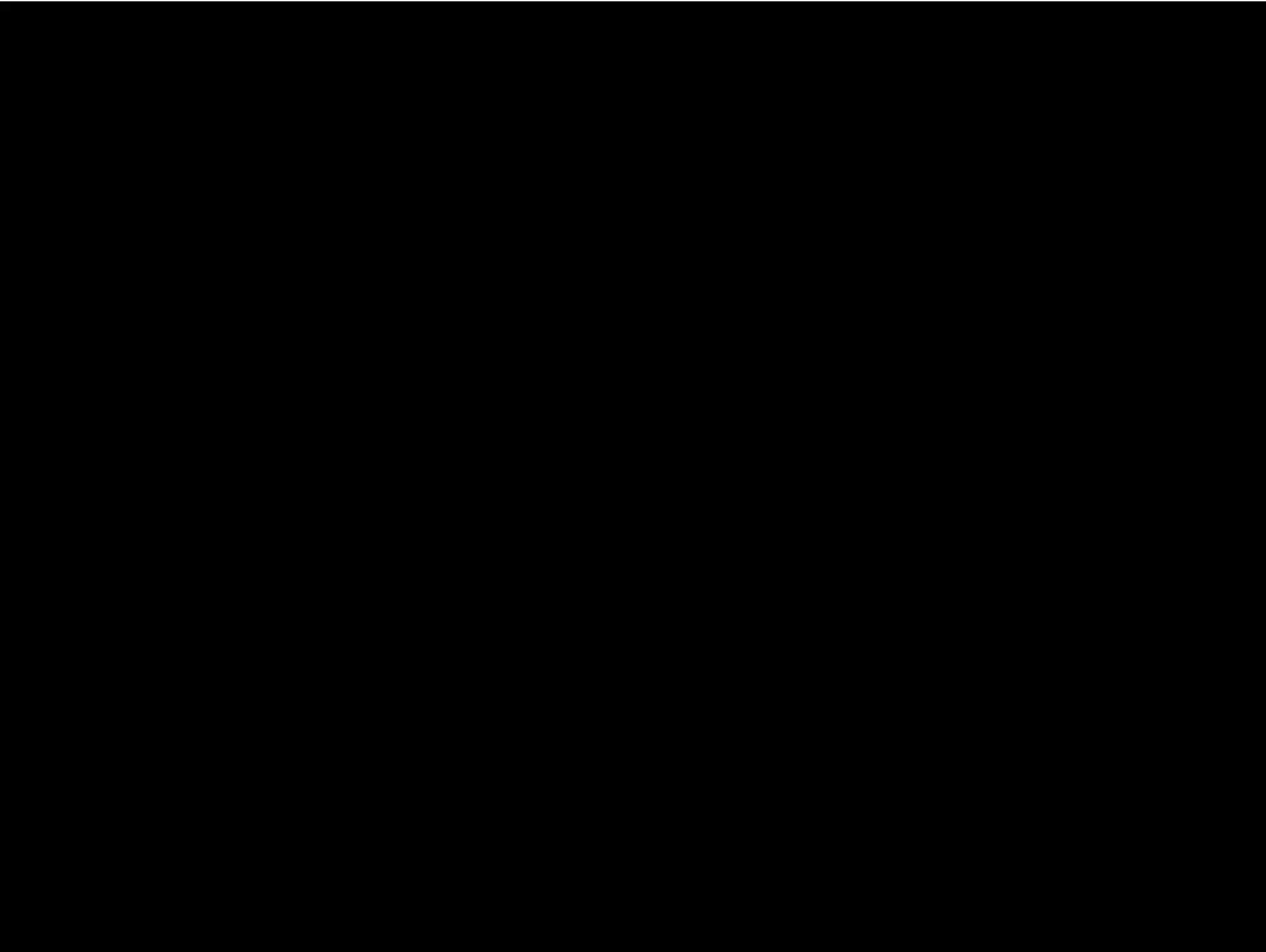


# Lightning

- Light = fast
- Sound = slow

See  
lightning  
before we  
hear it





# Recall – Properties of Light

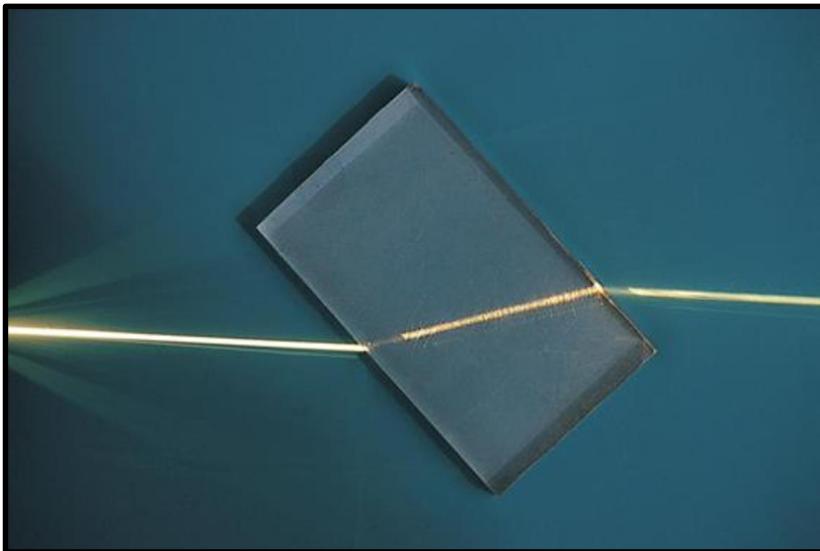
- 1) The sun is the main source of natural light
- 2) Light can be absorbed and reflected
- 3) Light travels in a straight line from its source

# Recall – Properties of Light

- 4) The speed of light is dependent on the material it is travelling through; light can be bent!
- 5) White light is made up of all the colours of light
- 6) Light energy can be transformed into other types of energy

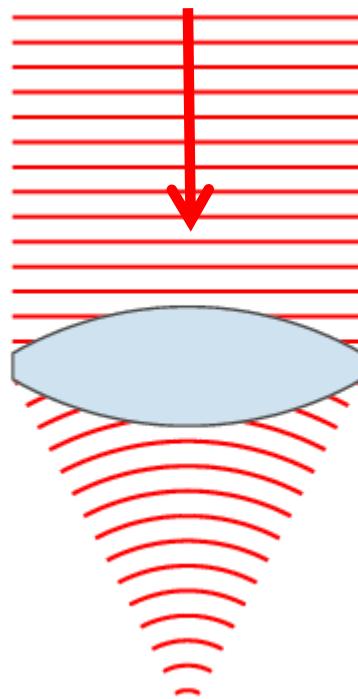
# Light Behaviour

- Light usually travels in a straight line
- Light can be bent
  - This is called refraction



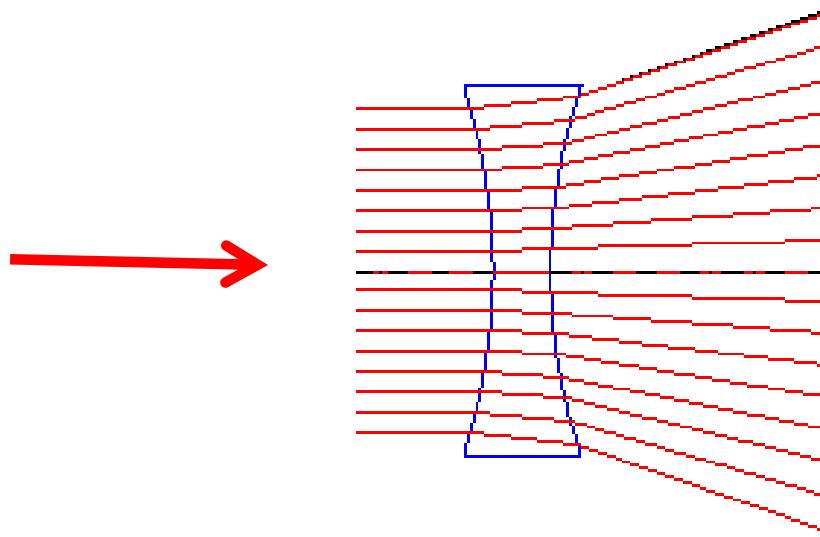
# Lenses

- We can use lenses to bend the light and focus it at one point
- This point is called the focal point



# Lenses

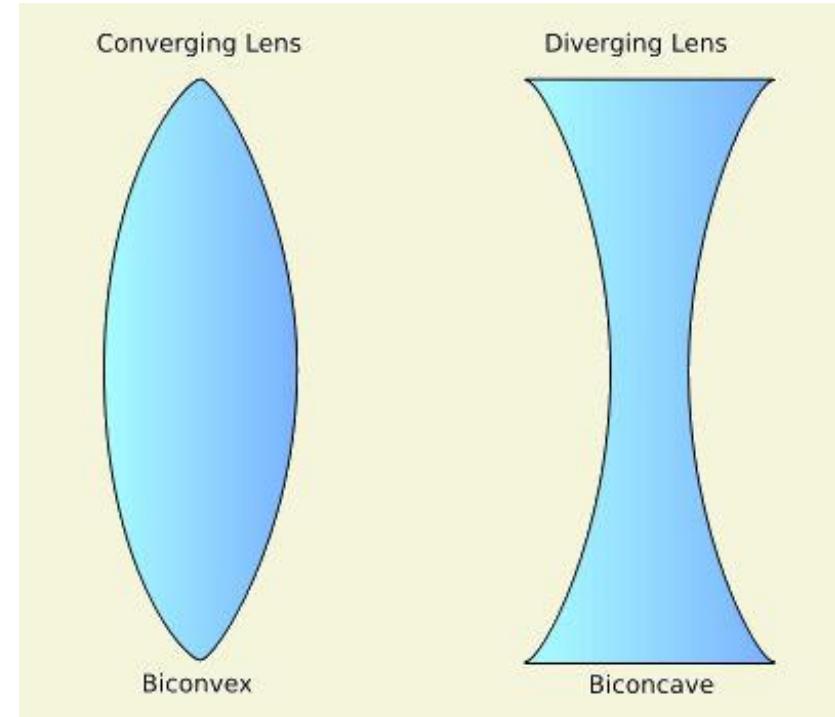
- We can also use lenses to spread the light waves outward
- We call this diverging the light



# Types of Lenses

- We have looked at 2 types of lenses:

- Convex lenses  
(biconvex)



- Concave lenses  
(biconcave)

