Washtenaw County Elementary Science Olympiad

Photon Phun Workshop 2

Wave and Light Properties

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Presented at Scarlett Middle School

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Recap from Workshop 1

- Light travels straight
- The angle between the incoming light and surface is the same as angle between the reflected light and the surface
- Use of protractor

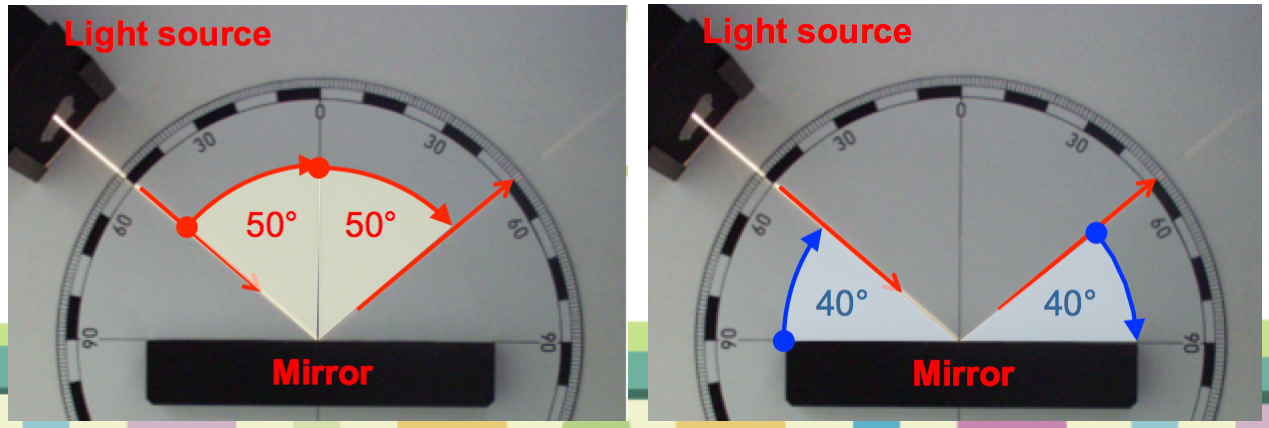


Image source: https://en.wikipedia.org/wiki/Reflection_(physics)

What will we learn today…?

- What is wave?
- Electromagnetic wave
- Electromagnetic spectrum & colors of light
- Prisms
- Grating and spectroscope

See materials section at the end for the supplies for activities

Examples of waves?

Examples of waves?

- Ocean waves
- Sound waves
- Waves on rope
- Light! (Of course!)

What is wave?

What is wave?

- Oscillation
- Something goes up and down
- Vibration

Activity 1: How do we create waves?

- Take a rope
- Have one person hold one side and make it pretty taut
- Another person wiggle one side
- Wiggle fast and slow; do you see a change?

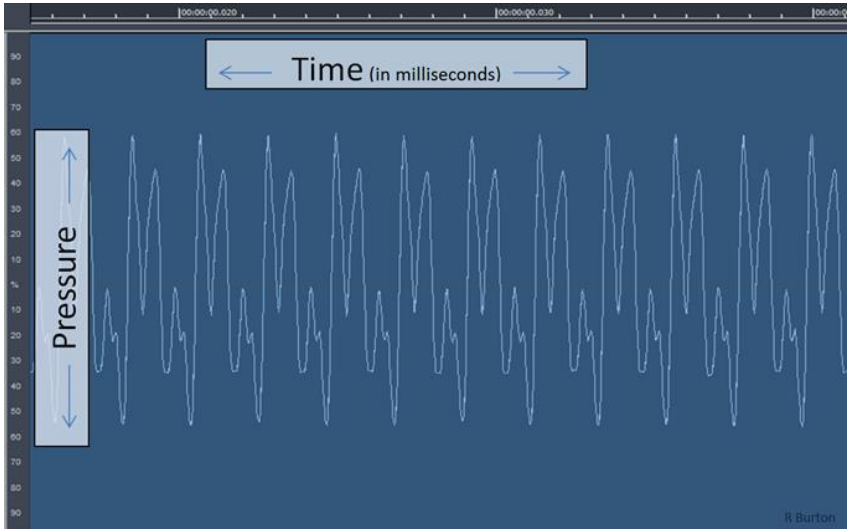
What makes waves?

What makes waves?

- Vibration
- Oscillation

Sound is a pressure wave

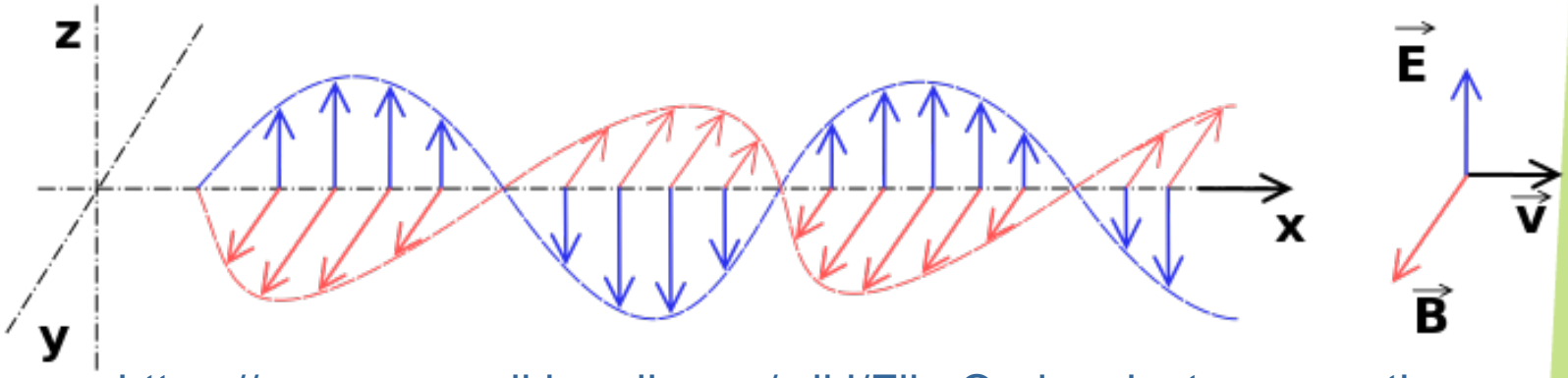
- Sound is a wave due to variation of density/pressure of air or other media



https://commons.wikimedia.org/wiki/File:The_Elements_of_Sound_jpg.jpg

Light is electromagnetic wave

- Electromagnetic wave has oscillating electric field and magnetic field
- These fields are coupled



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Characteristic of waves: Wavelength & frequency

- Wavelength = length of the repeating unit (example: the maximum to next maximum point)

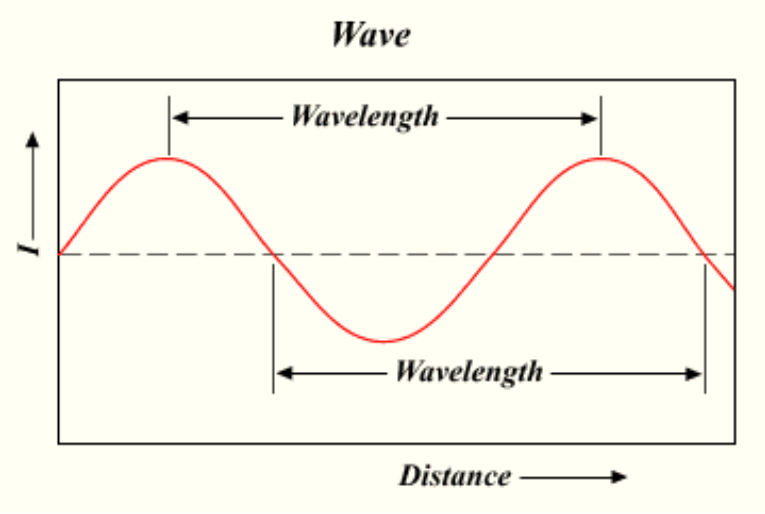

Image by Bryan Derksen (on English Wikipedia)

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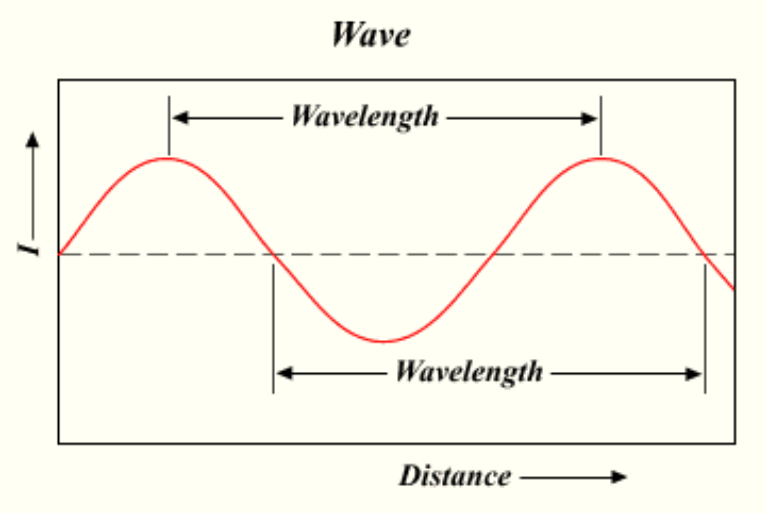

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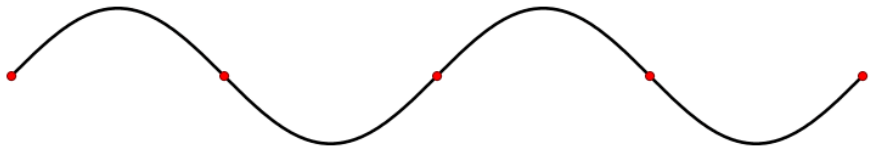
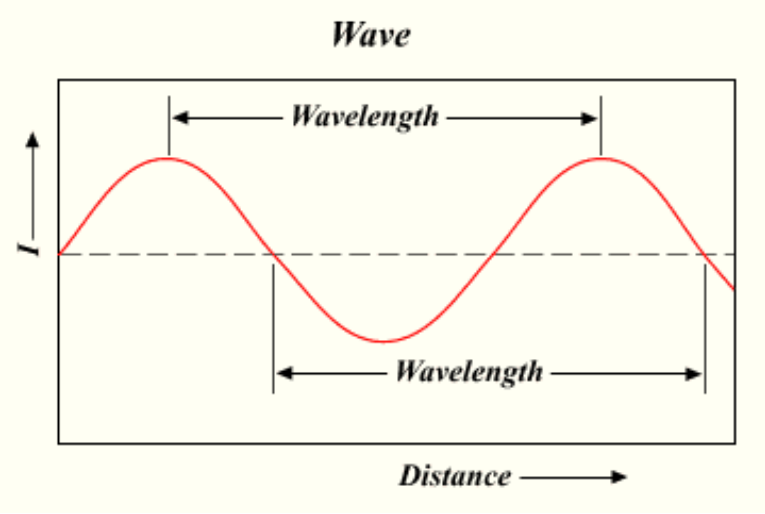


Image: https://en.wikipedia.org/wiki/Standing_wave

Characteristic of waves: Wavelength & frequency

- Wavelength = length of the repeating unit (example: the maximum to next maximum point)
- Frequency = how frequently it goes from one shape to the same shape again



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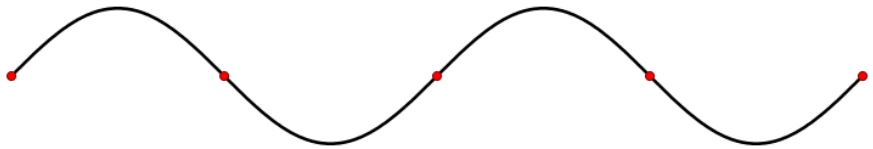
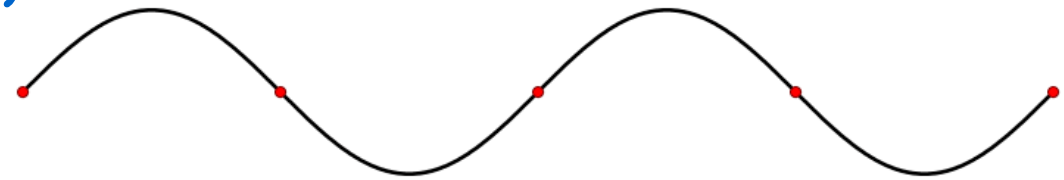


Image: https://en.wikipedia.org/wiki/Standing_wave

Activity 2: Wave Characteristic Exercise (see the handout)

- Count how many times this wave goes up and down in one minute (use the cell phone timer)



- Frequency = (the count)/min
  = (the count/60sec)
- 1 Hz (1 Hertz) = 1/sec

Frequency & wavelength

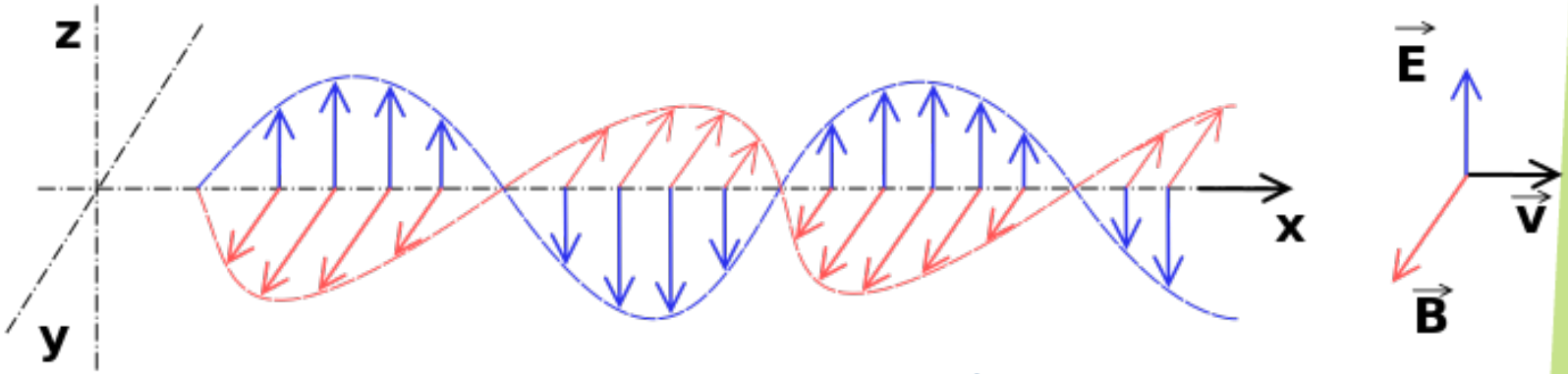
- Faster you wiggled the rope (higher frequency), the wavelength became _____.
- When you wiggled slower, the wave length became _____.
- The wavelength and frequency are **inversely** related.

Wavelength, frequency, and energy

- Do you put more energy to make a wave with longer wavelength?
- Do you put more energy to make a wave with shorter wavelength?
- Try out the rope again!

Electromagnetic (EM) wave

- Electromagnetic wave has oscillating electric field and magnetic field
- These fields are coupled
- We will focus on EM wave from here on



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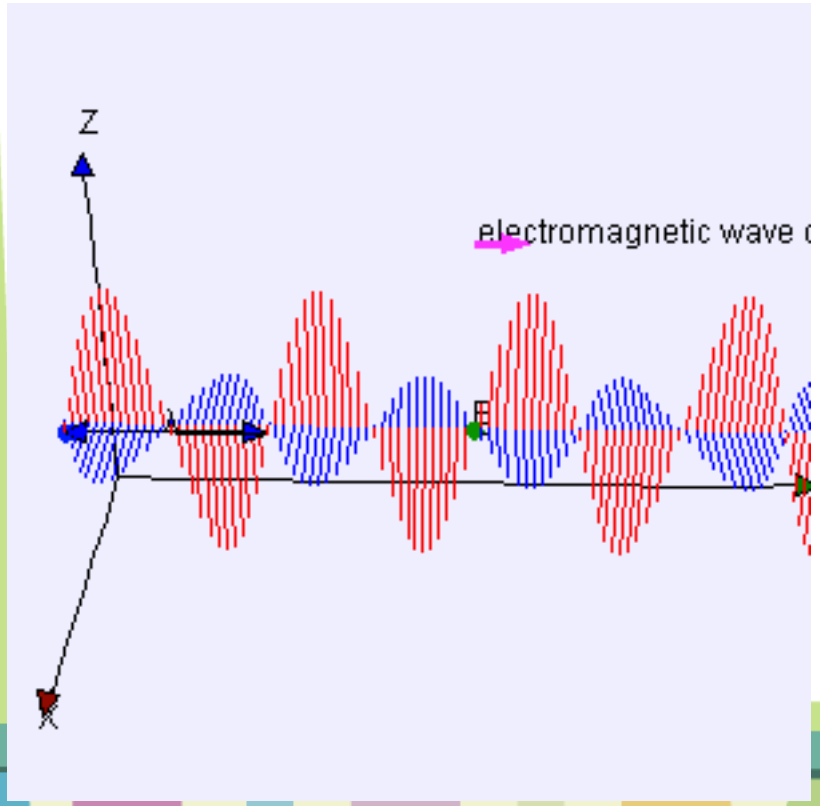
Visualizing EM wave

- EM waves travels



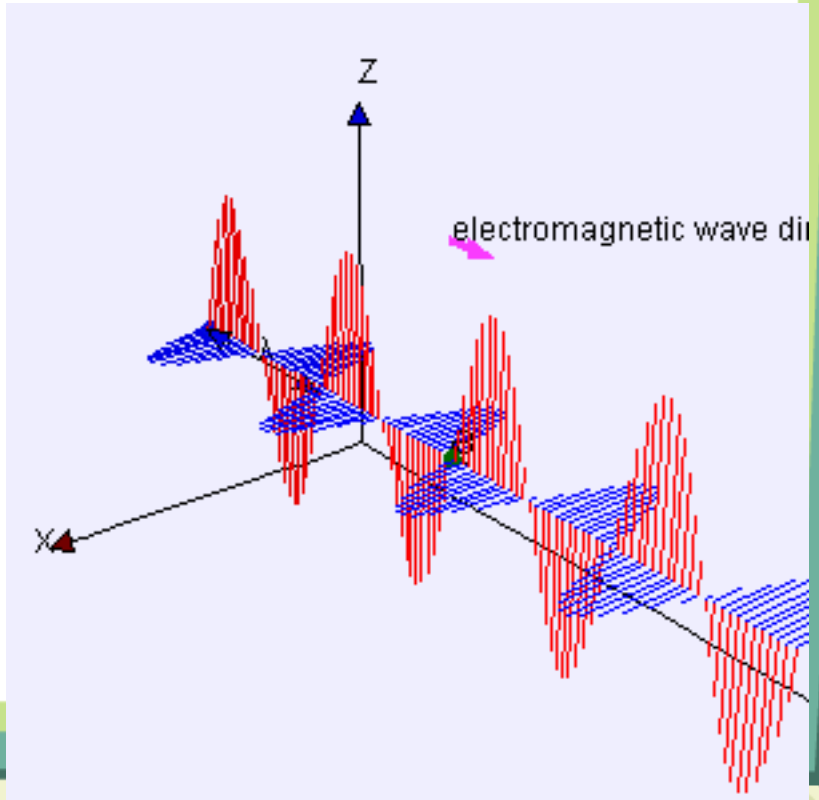


Image: https://en.wikipedia.org/wiki/Electromagnetic_radiation

Wavelength/frequency determine the color (many of them we can't see!)

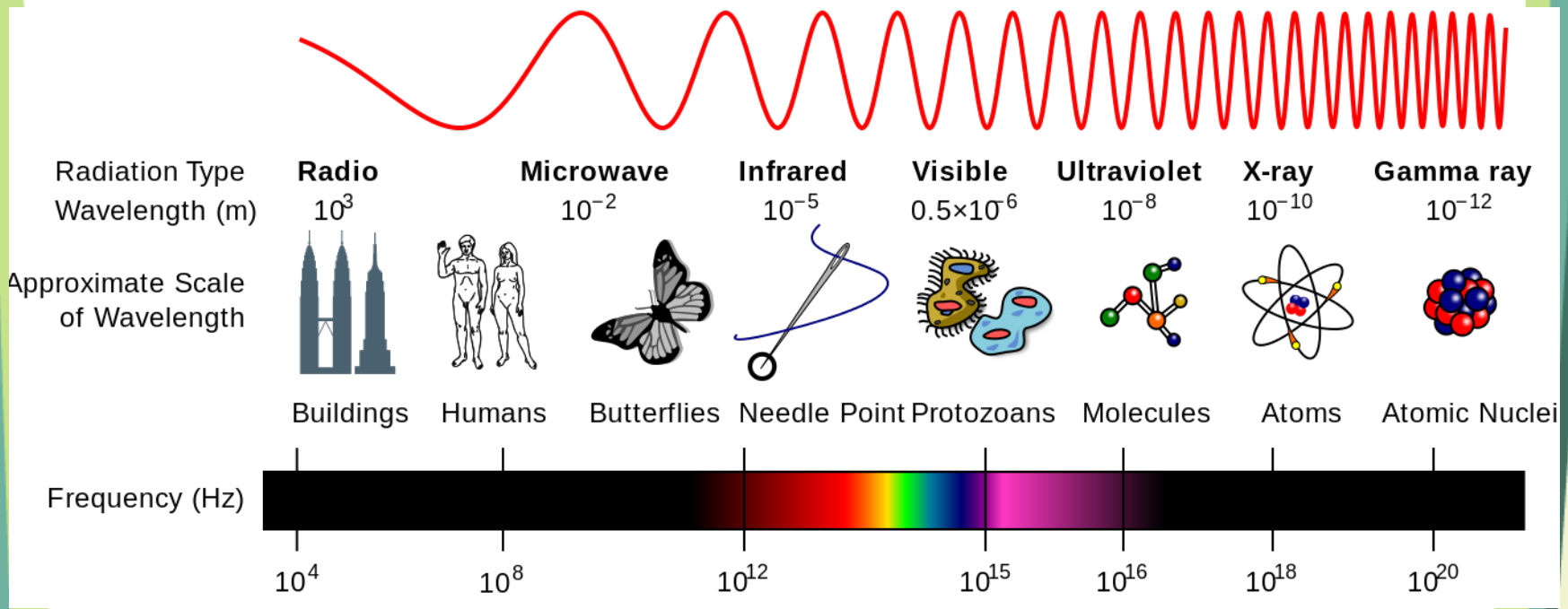


Image: https://en.wikipedia.org/wiki/Electromagnetic_spectrum#/media/File:EM_Spectrum_Properties_edit.svg

Visible light

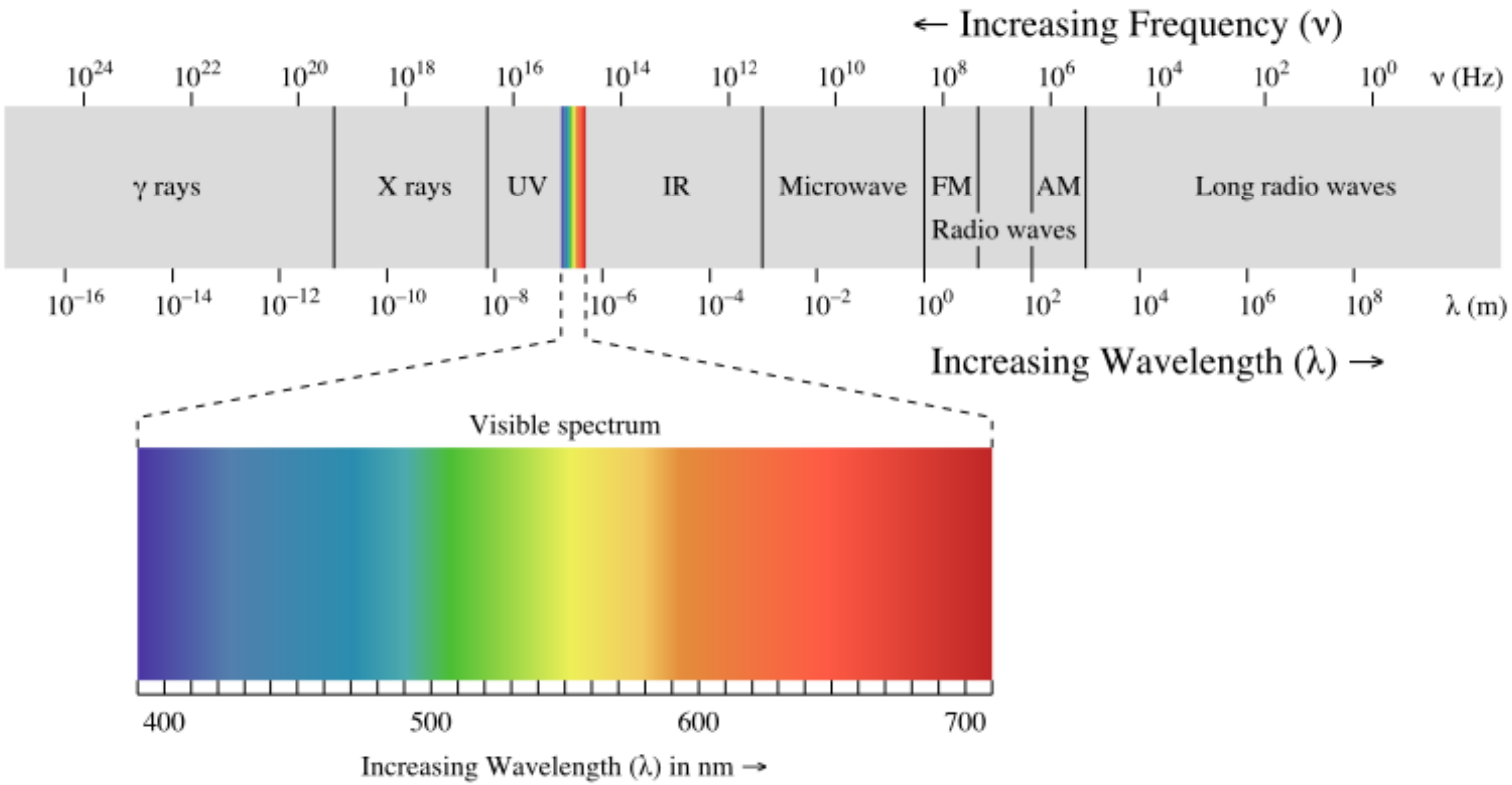


Image: https://commons.wikimedia.org/wiki/File:EM_spectrum.svg

Different light source gives out different wavelengths

- White light is composed of at least three color of light
- Different source of light gives out different set of wavelengths/ frequencies of light

Prisms can spread light according to the wavelength!

- Light that pass through when they encounter a new medium (material) refracts (bends)
- Light with different colors interact differently with materials and bend differently

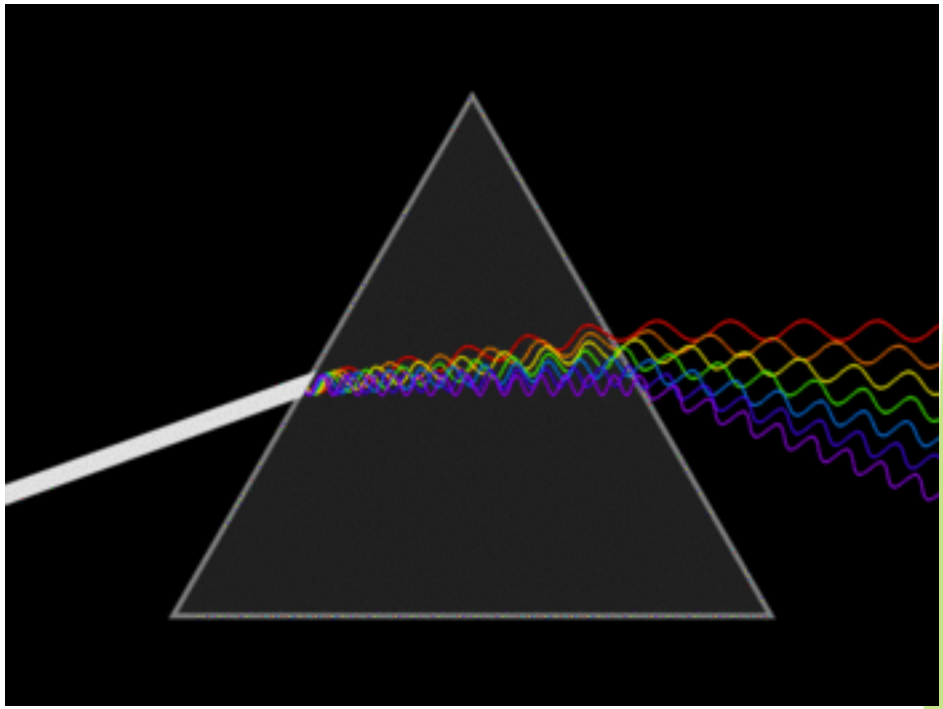


Image: https://commons.wikimedia.org/wiki/File:Light_dispersion_conceptual_waves350px.gif

Grating can also spread light

- Diffraction happens because a wave adds constructively or distractively

These two waves adds to this

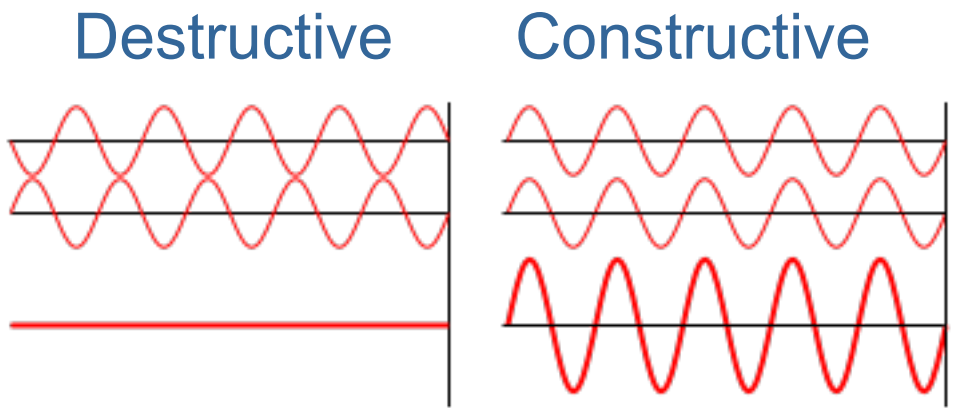


Image: https://commons.wikimedia.org/wiki/File:Interference_of_two_waves.svg

Depending on the wavelengths, it adds up constructively at certain angles

- This is why you see colors on bubbles!
- We use a CD, which acts as a diffraction grating because of the grooves on the surface

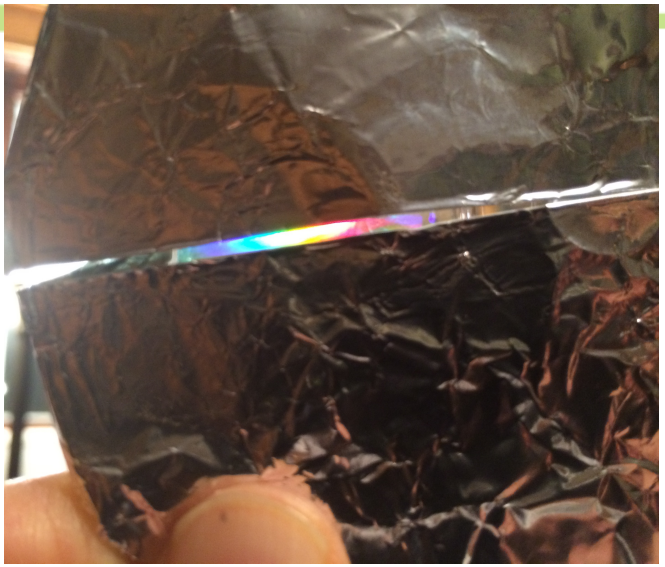
https://en.wikipedia.org/wiki/Interference_(wave_propagation)
https://en.wikipedia.org/wiki/Diffraction_grating

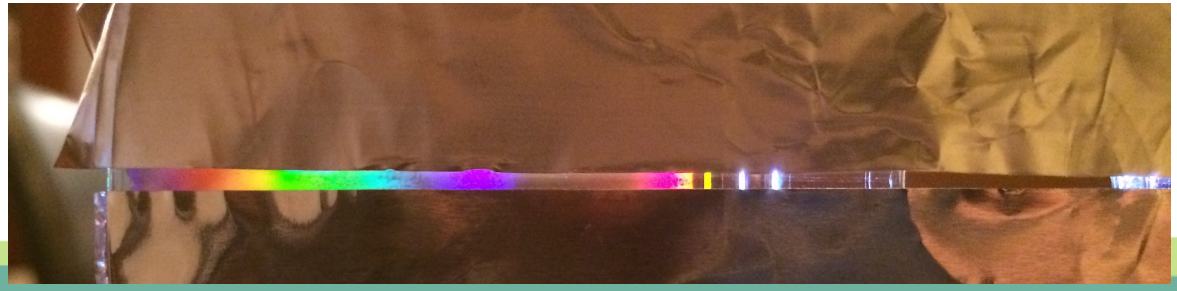
Activity 3: Handmade Spectroscope

- Make a small scratch on a CD-R
- Put a tape on the scratch and over the CD; pull off to remove the reflective material; repeat until all removed
- Cover half of the CD with a foil with straight edge
- Cover the other side with another piece, leaving 1mm gap
- Look at different light sources!

What did you see?

- Continuous spectrum?
- Discrete (disconnected) spectrum?
- What was your favorite?





Take-away…

- Light is EM wave
- A wave is characterized by their wavelength/frequency; you learned how to measure them
- Wavelength/frequency determine the color; visible range is ~400nm to ~700 nm
- You can use prisms or grating to separate the color

Thanks!

Questions?

Supplementary Materials for Coaches and Parents

Activity Materials

- Activity 1: A good jump rope
- Activity 2: CD or CD-R (CD-R was used in the workshop), something to scratch the CD (a bent paper clip would do), a packing tape, aluminum foil