

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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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?



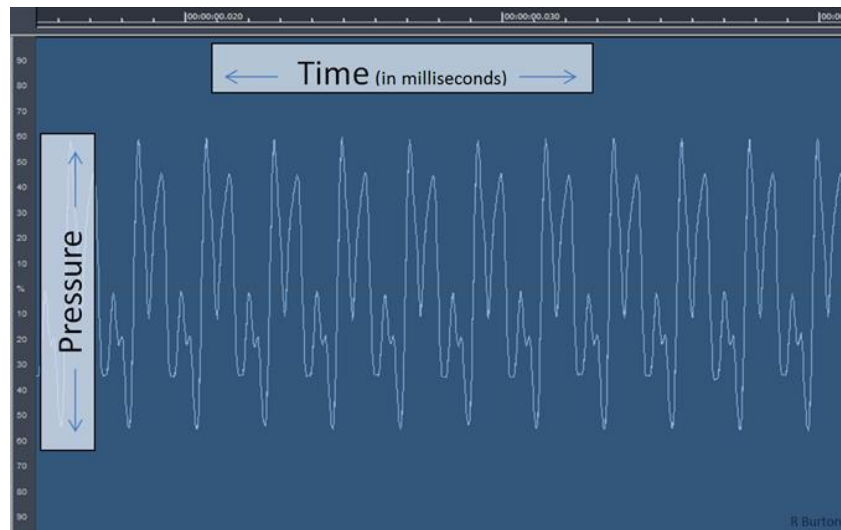
What makes waves?

What makes waves?

- * Vibration
- * Oscillation

Sound is a pressure wave

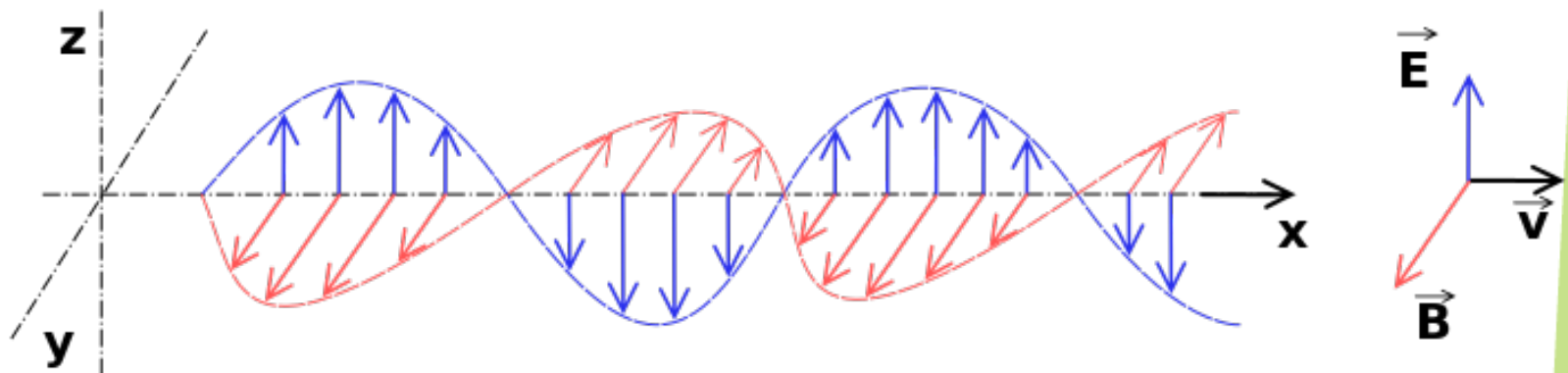
- * Sound is a wave due to variation of density/pressure of air or other media



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



https://commons.wikimedia.org/wiki/File:Onde_electromagnetique.svg

Characteristic of waves: Wavelength & frequency

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

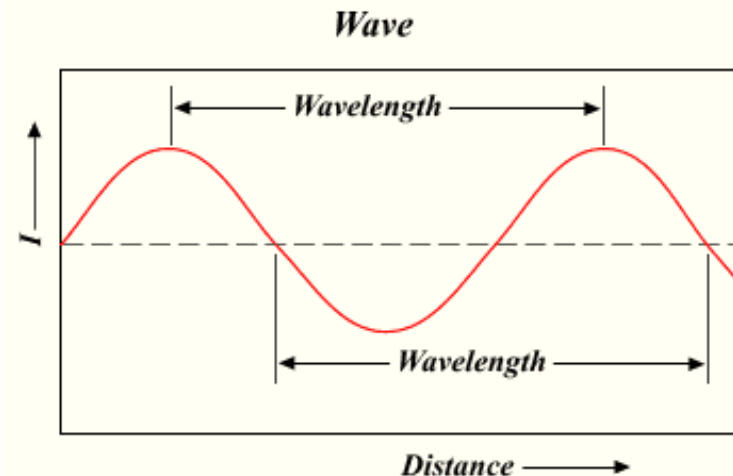


Image by Bryan Derksen (on English Wikipedia)

Characteristic of waves: Wavelength & frequency

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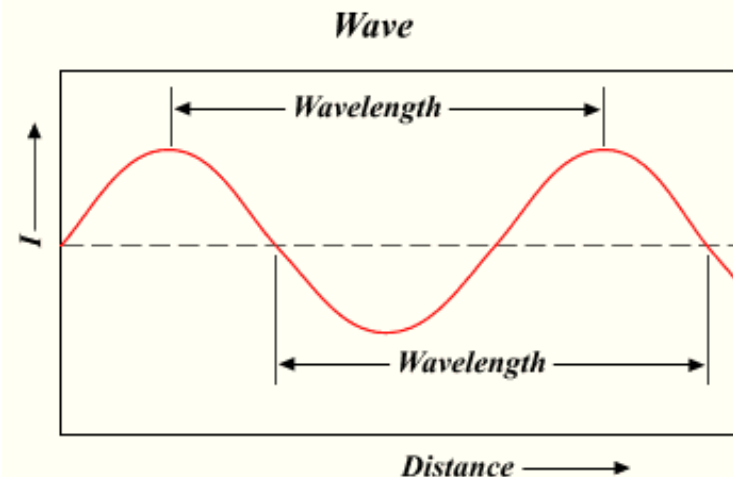


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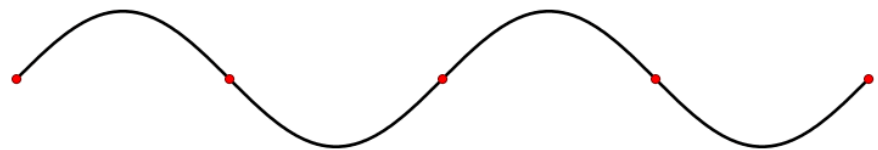


Image: https://en.wikipedia.org/wiki/Standing_wave

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

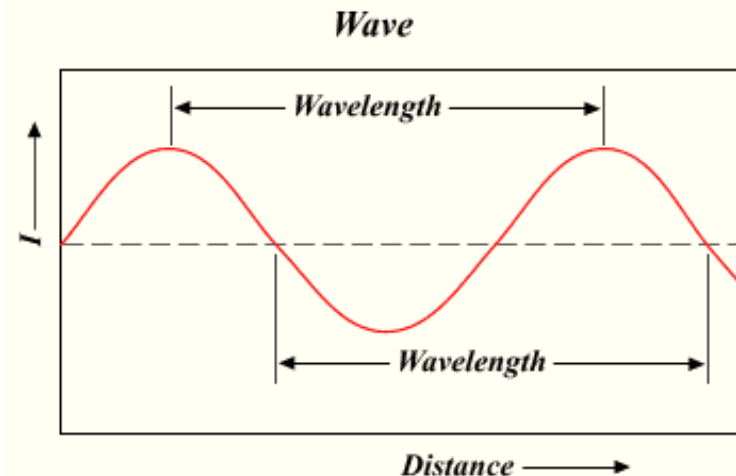


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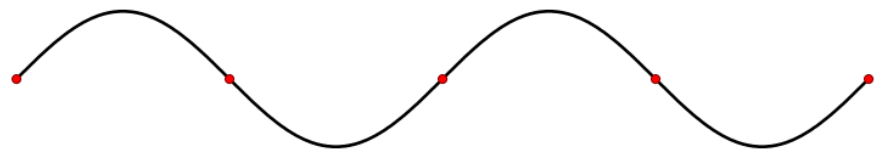


Image: https://en.wikipedia.org/wiki/Standing_wave

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

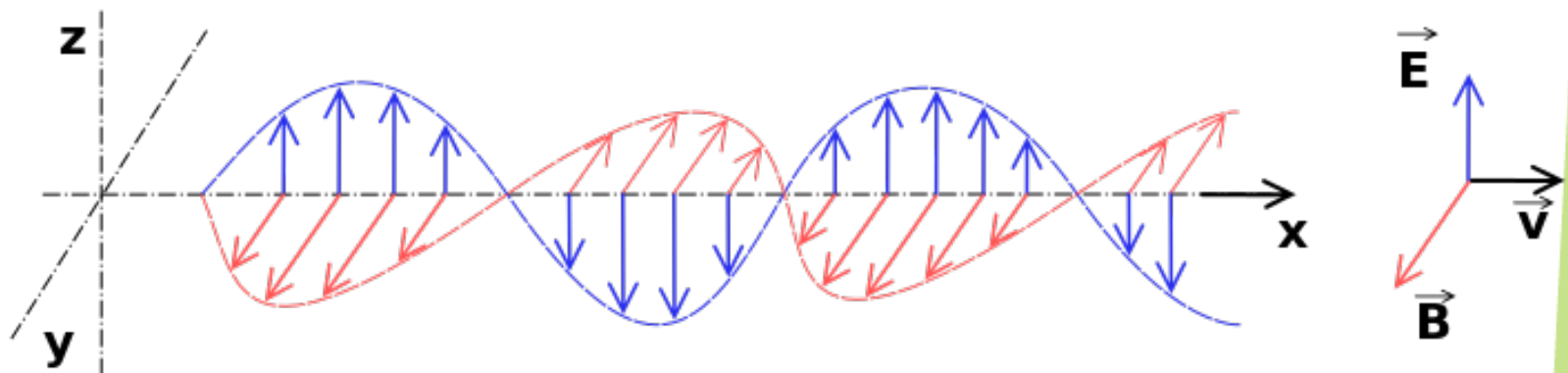
- * Faster you wiggled the rope (higher frequency), the wavelength became _____.
- * When you wiggled slower, the wave length became _____.
- * The wavelength and frequency are **inversely** related.

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



https://commons.wikimedia.org/wiki/File:Onde_electromagnetique.svg

Visualizing EM wave

★ EM waves travels

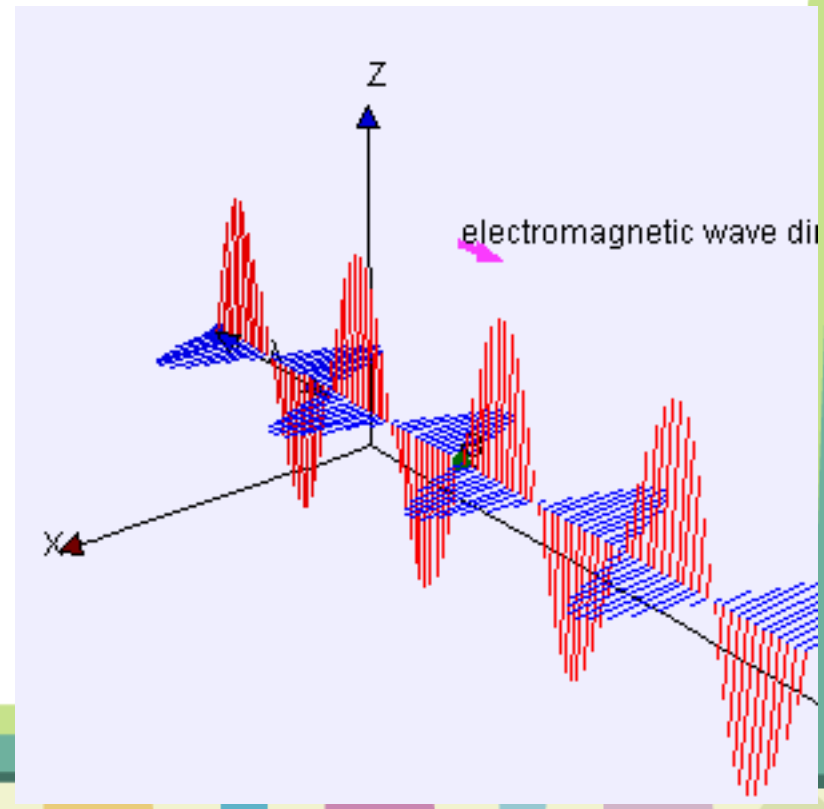
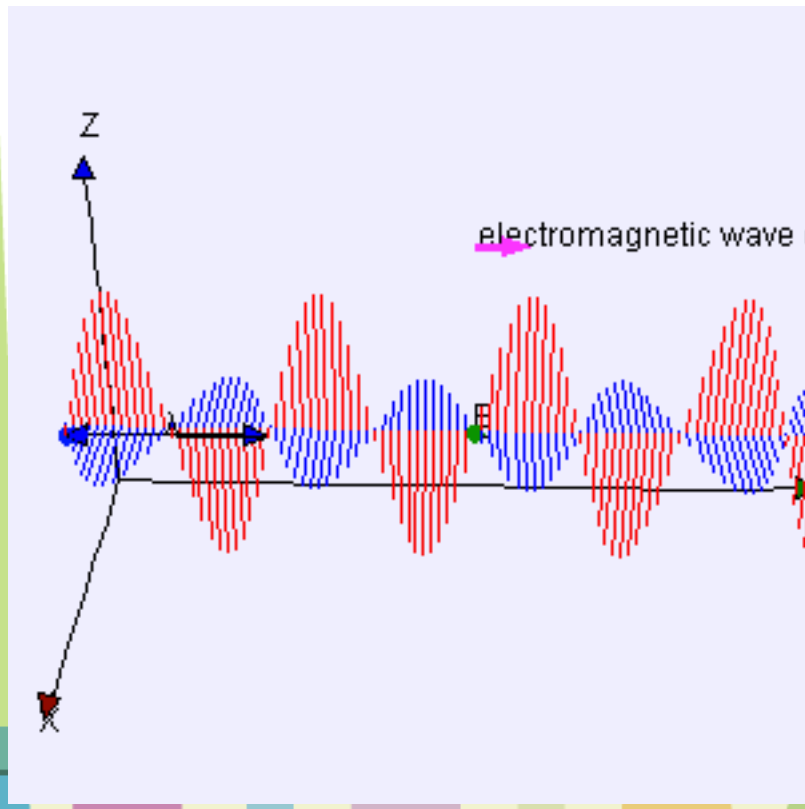


Image: https://en.wikipedia.org/wiki/Electromagnetic_radiation

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

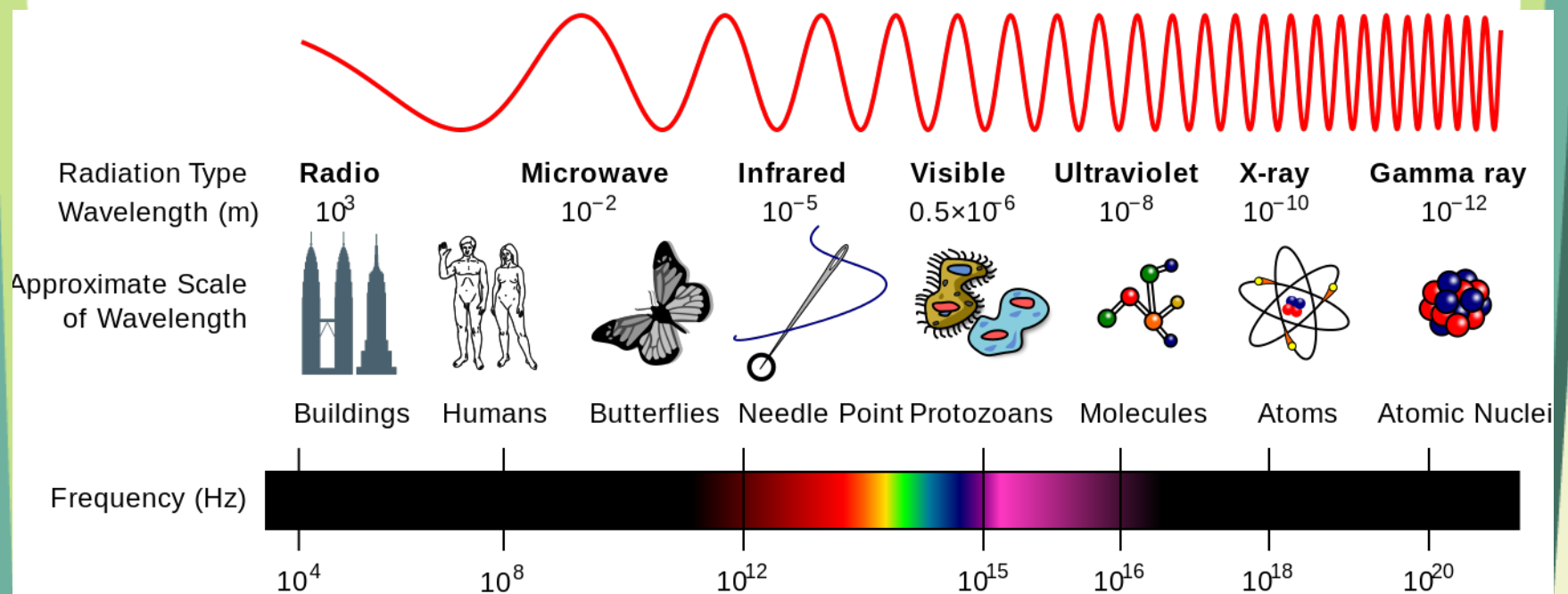


Image: https://en.wikipedia.org/wiki/Electromagnetic_spectrum#/media/File:EM_Spectrum_Properties_edit.svg

Visible light

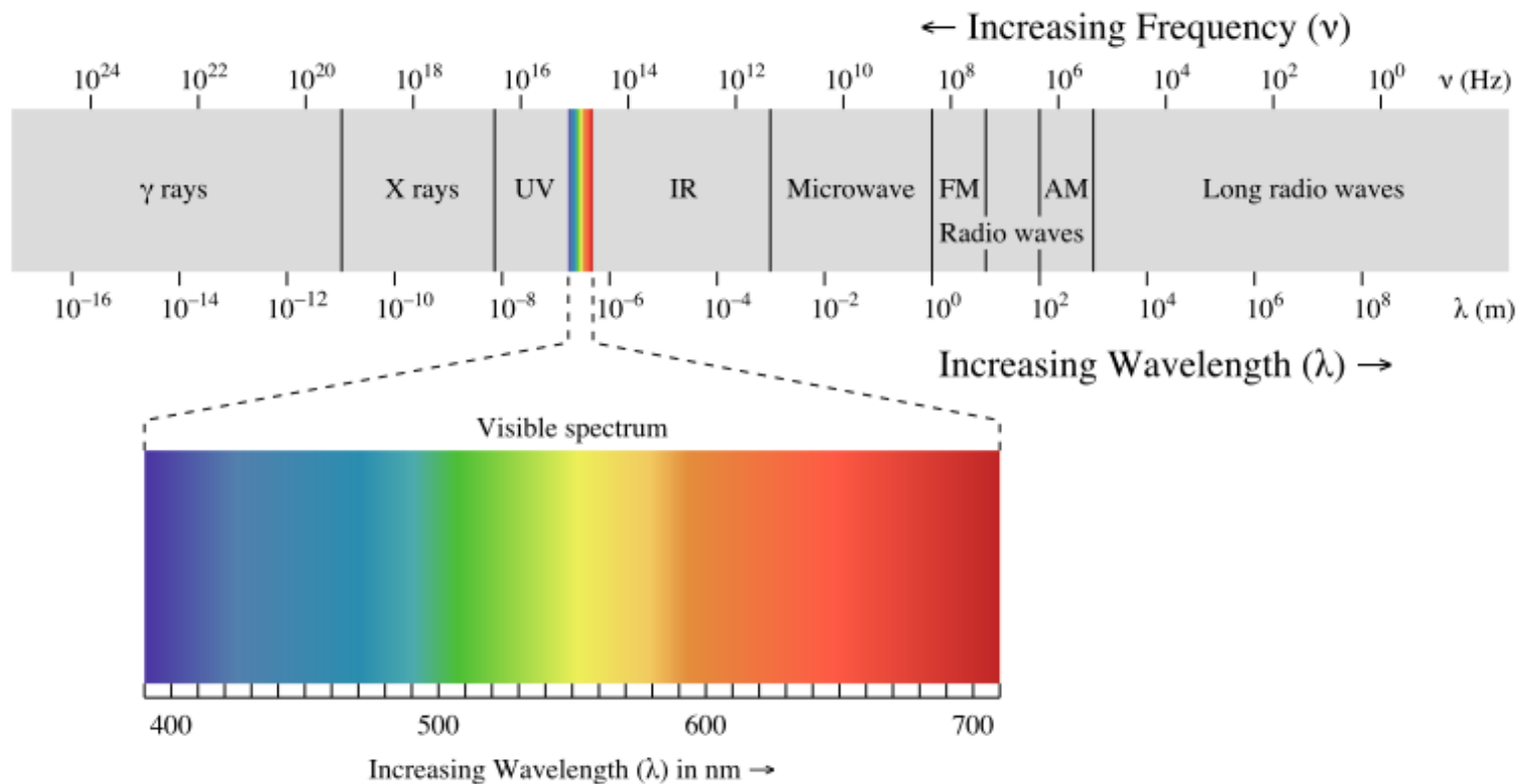


Image: https://commons.wikimedia.org/wiki/File:EM_spectrum.svg

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

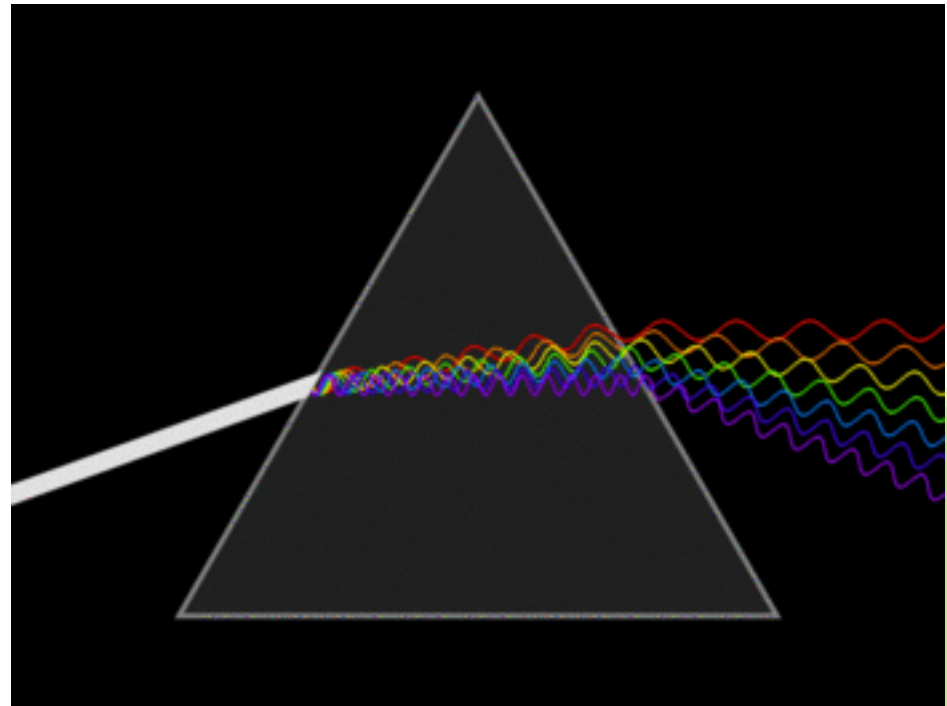


Image: https://commons.wikimedia.org/wiki/File:Light_dispersion_conceptual_waves350px.gif

Grating can also spread light

- ★ Diffraction happens because a wave adds constructively or destructively

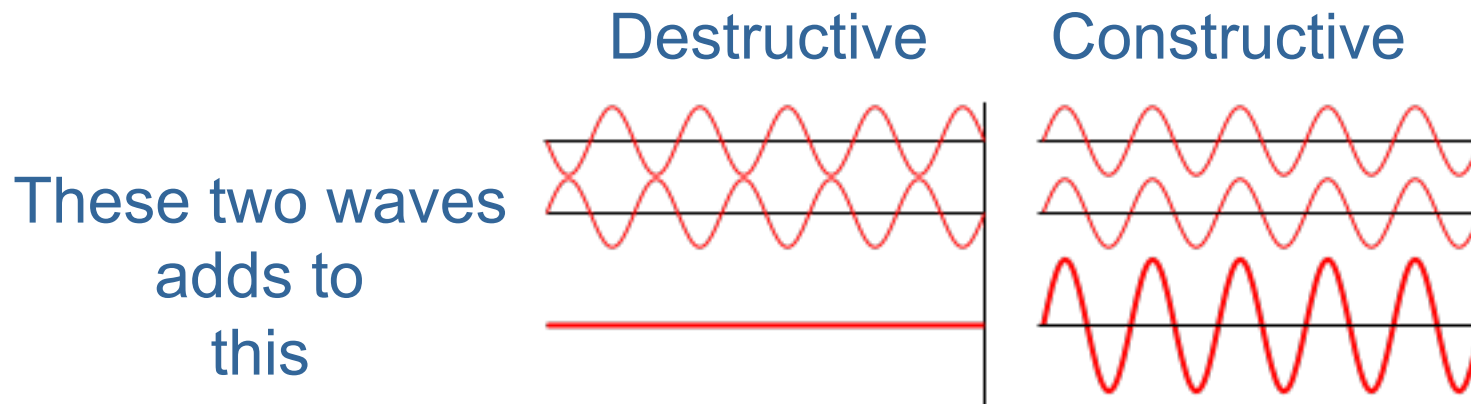


Image: https://commons.wikimedia.org/wiki/File:Interference_of_two_waves.svg

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/Interference_(wave_propagation))

https://en.wikipedia.org/wiki/Diffraction_grating

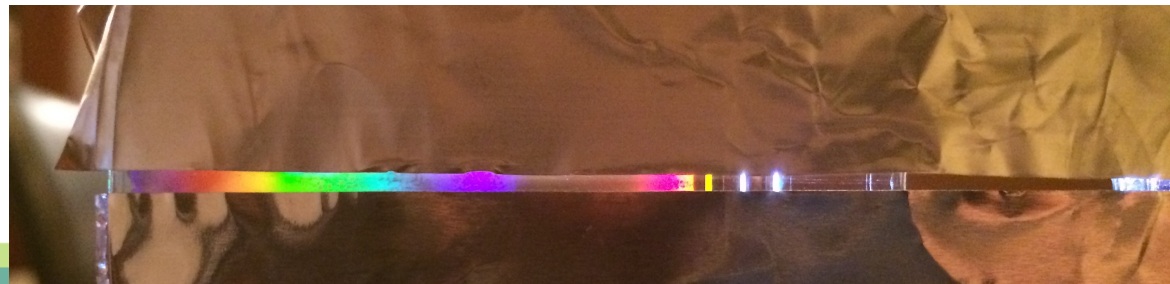
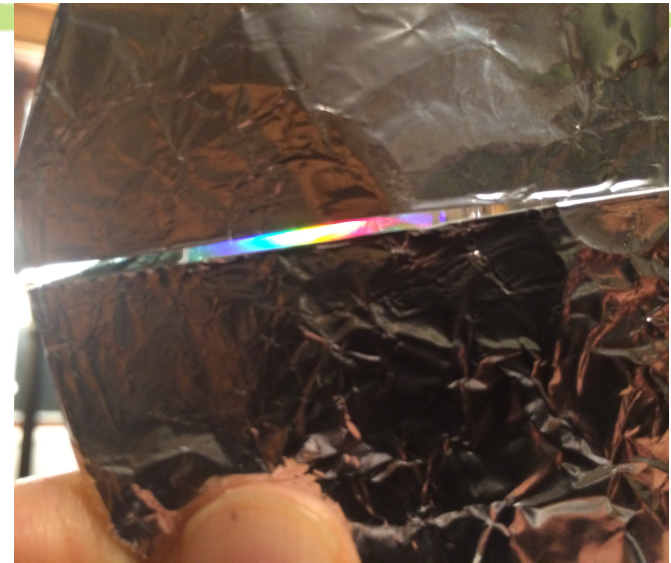
Activity 3: Handmade Spectroscope

- * 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



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 $\sim 400\text{nm}$ to $\sim 700\text{ nm}$
- * You can use prisms or grating to separate the color

The background of the slide features a series of vertical stripes in various colors including blue, purple, green, yellow, and orange. Overlaid on this background is a large, white trapezoidal shape that serves as a frame. This frame is composed of several concentric borders in shades of green and blue. Centered within this white frame is the text "Thanks!" in a dark green font, and below it, "Questions?" in a blue font.

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 packing tape, aluminum foil