

# Washtenaw County Elementary Science Olympiad

## Photon Phun Workshop 2

Wave and Light Properties

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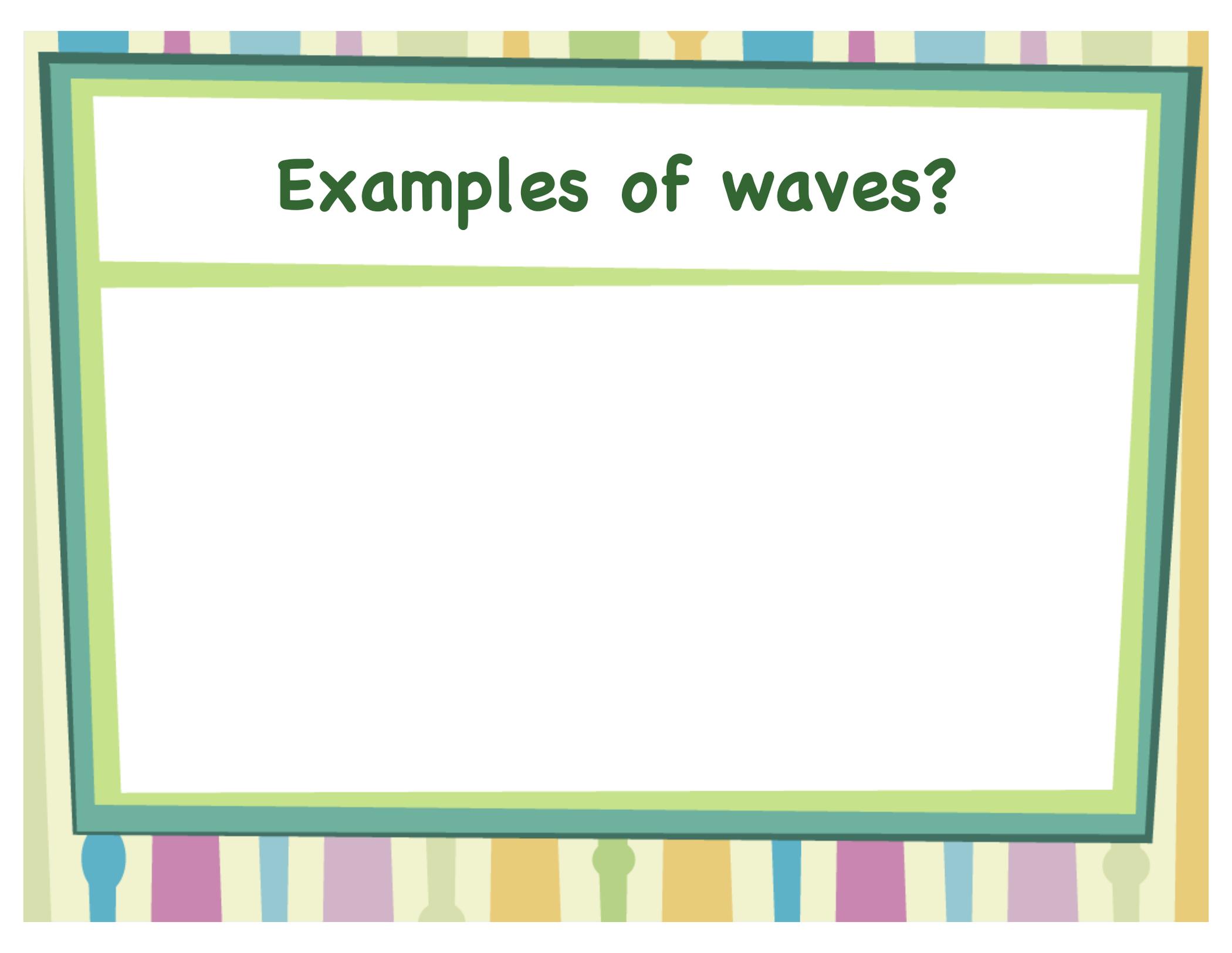
Presented at Scarlett Middle School

Financial support by National Science Foundation

# What will we learn today...?

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

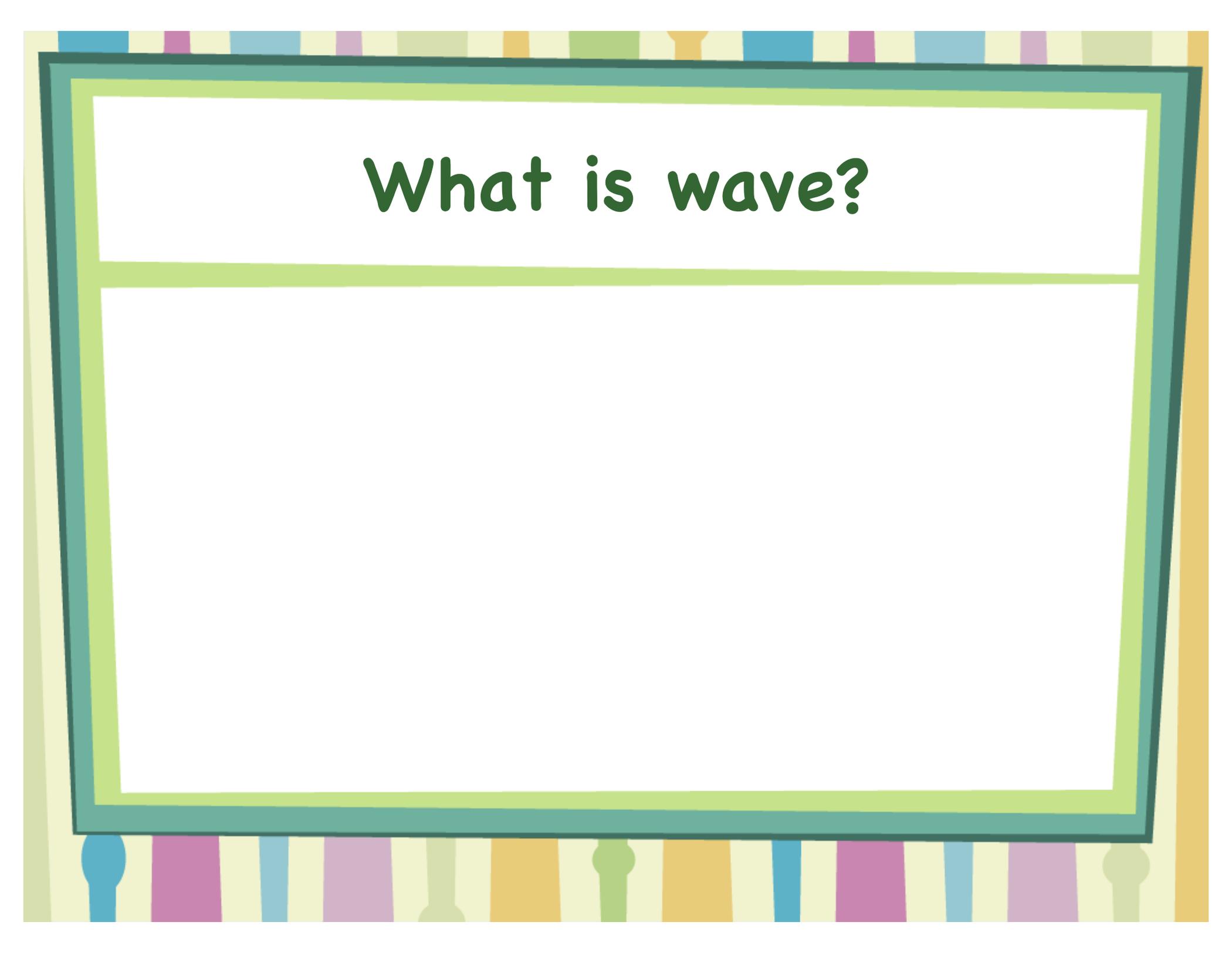
See materials section at the end for the supplies for activities



**Examples of waves?**

# Examples of waves?

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



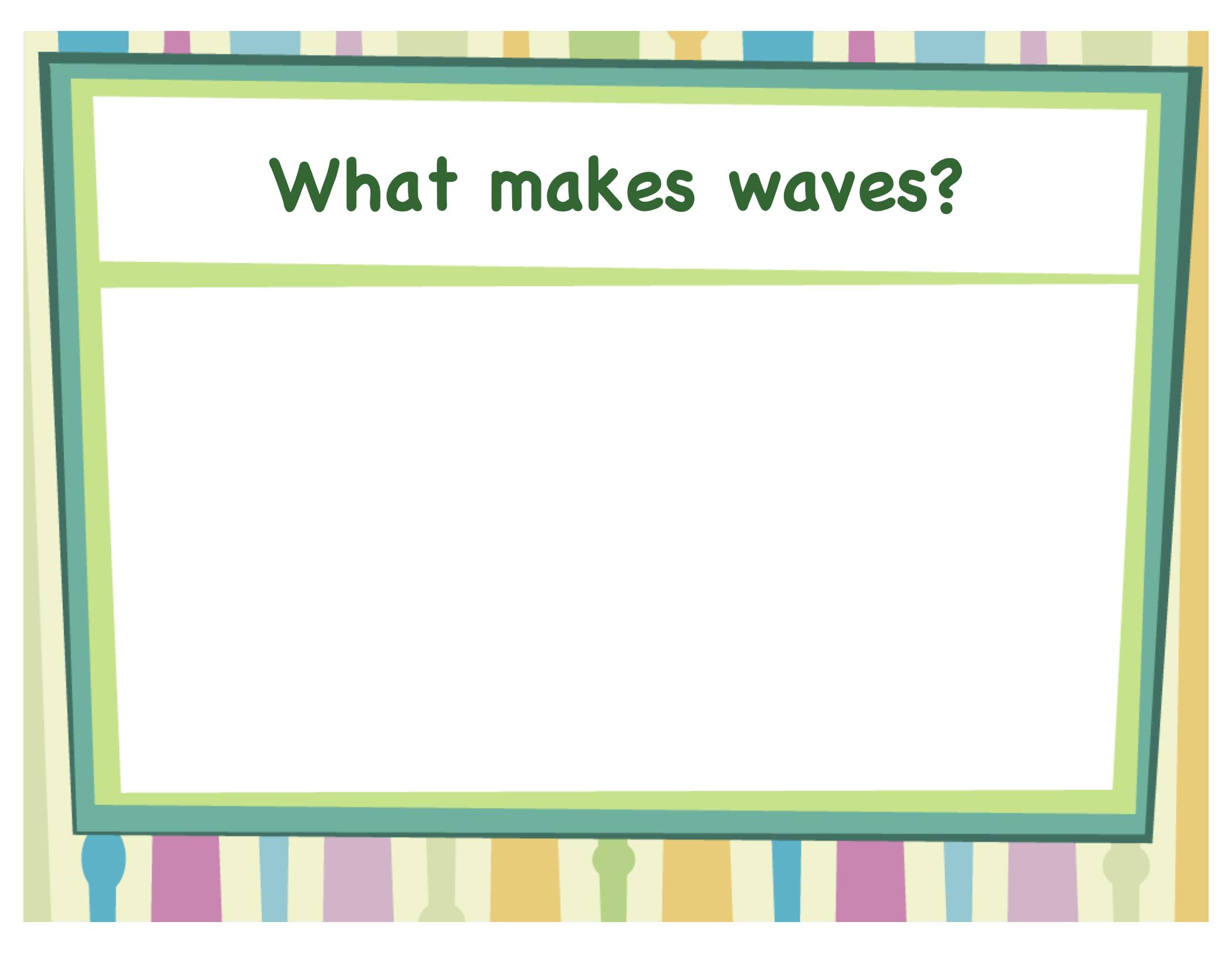
**What is wave?**

# 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?



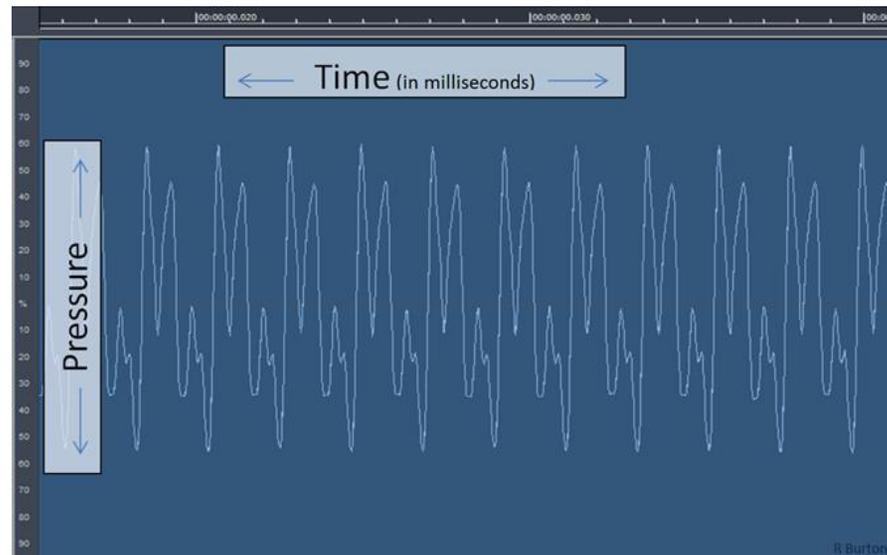
**What makes waves?**

# What makes waves?

- \* **Vibration**
- \* **Oscillation**

# Sound is a pressure wave

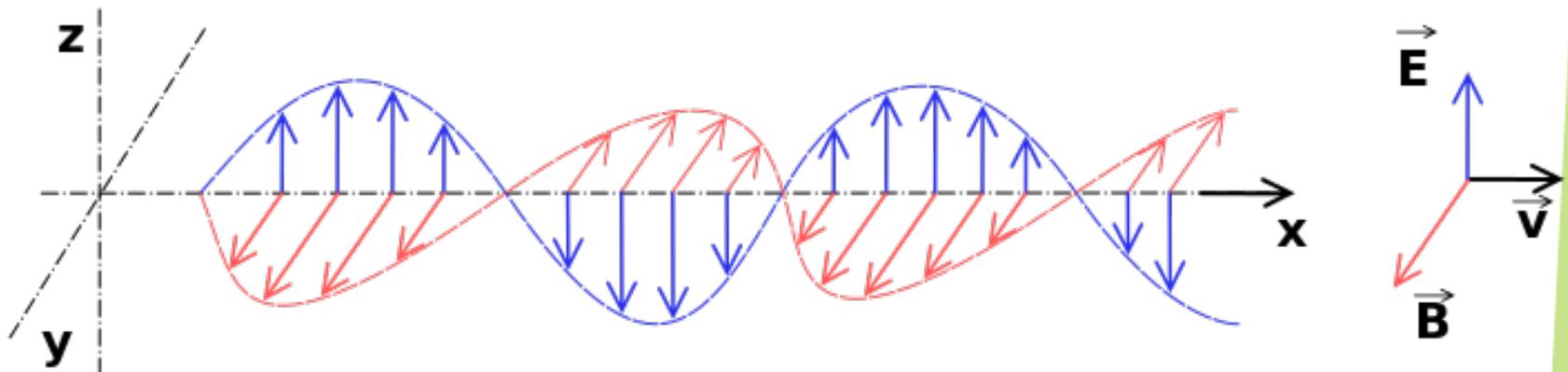
- \* Sound is a wave due to variation of density/pressure of air or other media



[https://commons.wikimedia.org/wiki/File:The\\_Elements\\_of\\_Sound\\_jpg.jpg](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](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)

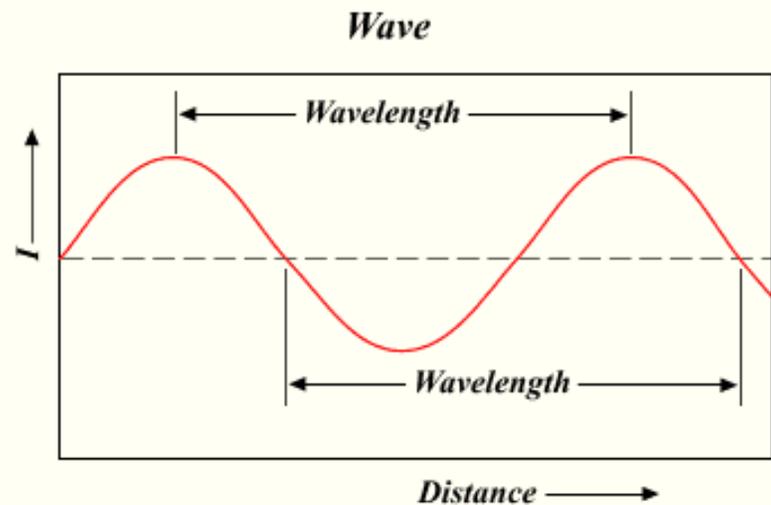


Image by Bryan Derksen (on English Wikipedia)

# Characteristic of waves: Wavelength & frequency

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

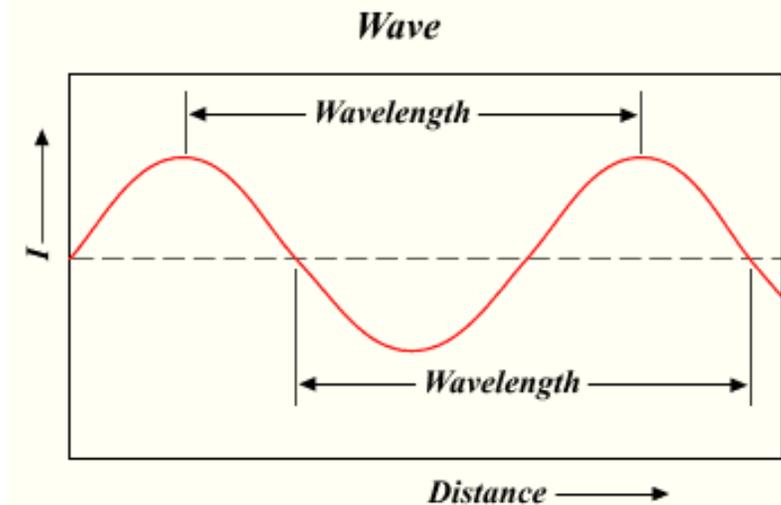


Image by Bryan Derksen (on English Wikipedia)

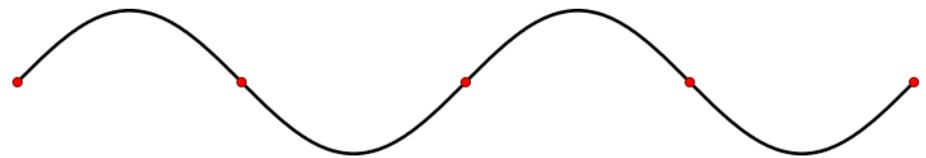


Image: [https://en.wikipedia.org/wiki/Standing\\_wave](https://en.wikipedia.org/wiki/Standing_wave)

# 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

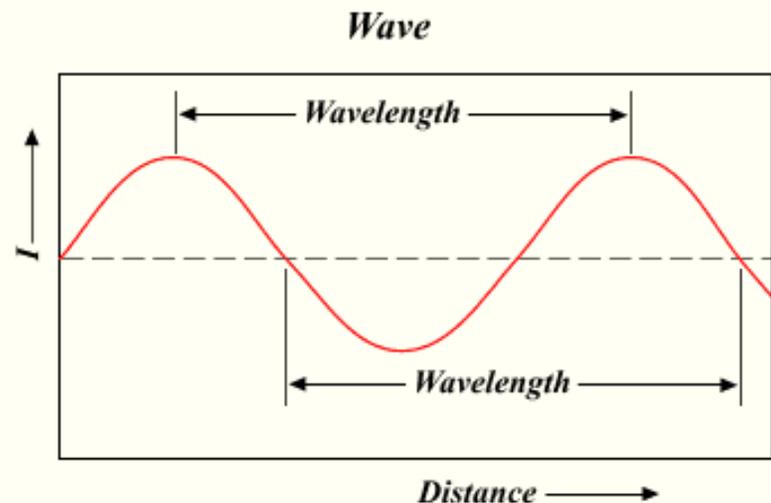


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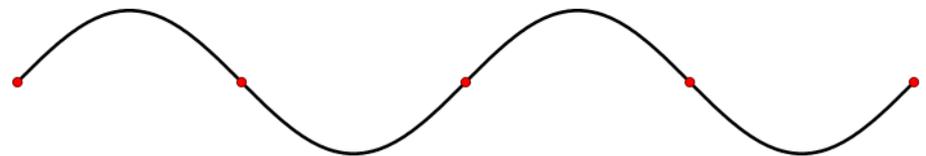
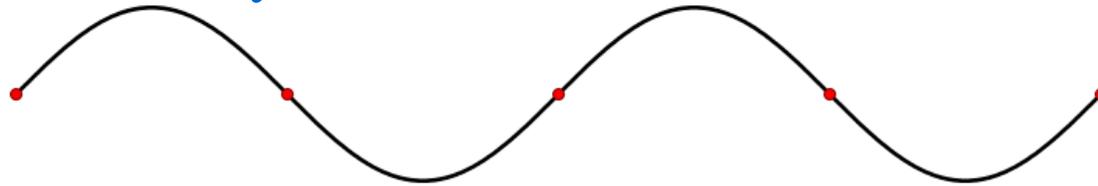


Image: [https://en.wikipedia.org/wiki/Standing\\_wave](https://en.wikipedia.org/wiki/Standing_wave)

## 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

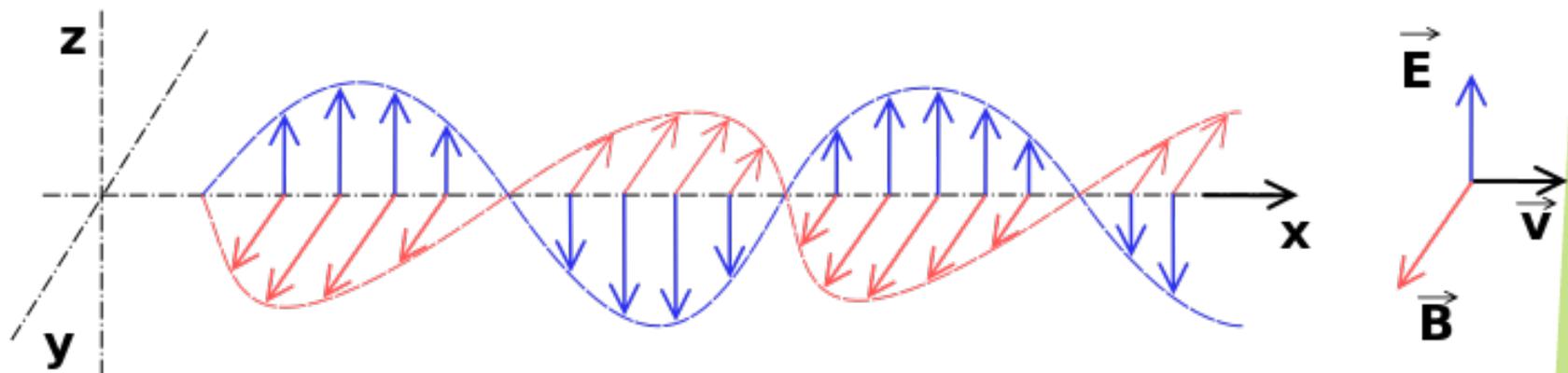
- \* Faster you wiggled the rope (higher frequency), the wavelength became \_\_\_\_\_.
- \* When you wiggled slower, the wave length became \_\_\_\_\_.
- \* The wavelength and frequency are inversely related.

# 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](https://commons.wikimedia.org/wiki/File:Onde_electromagnetique.svg)

# Visualizing EM wave

## \* EM waves travels

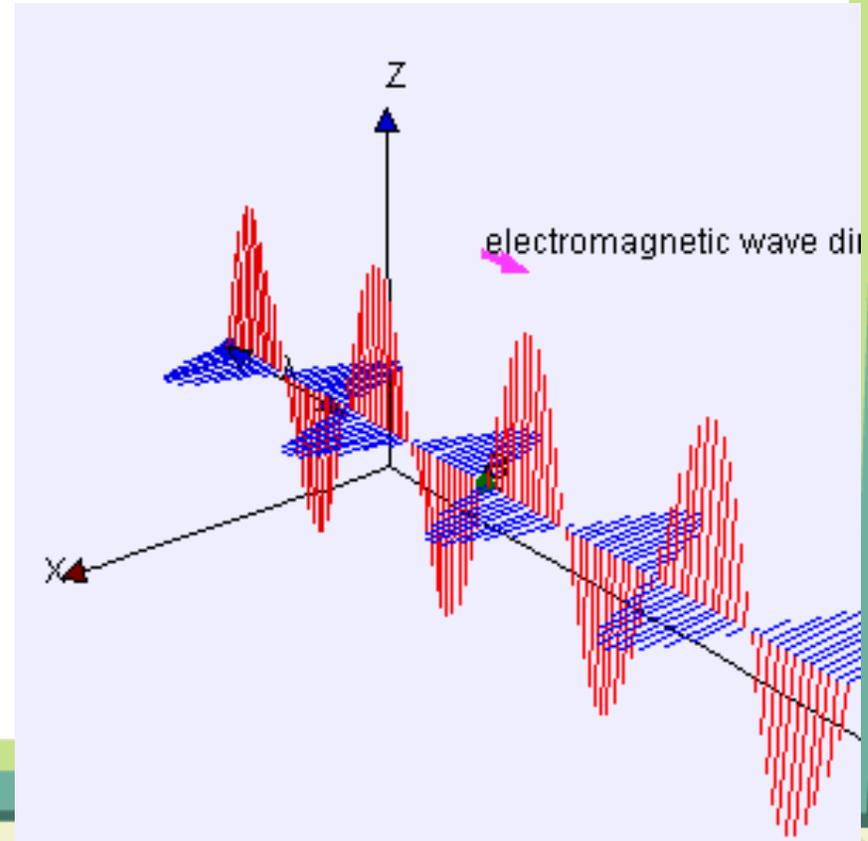
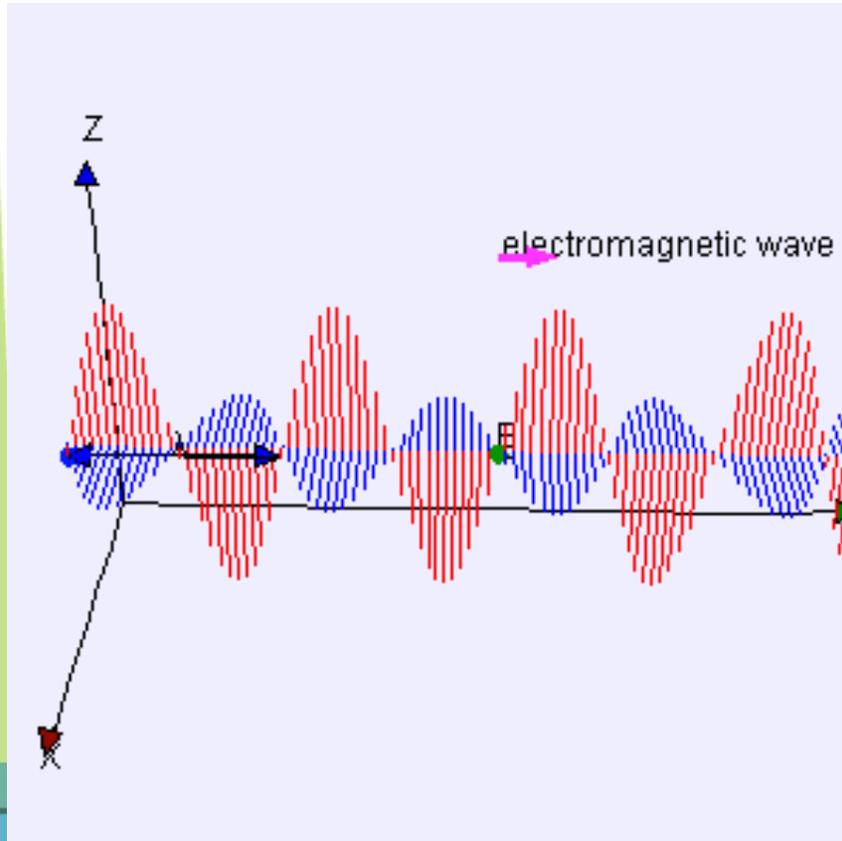


Image: [https://en.wikipedia.org/wiki/Electromagnetic\\_radiation](https://en.wikipedia.org/wiki/Electromagnetic_radiation)

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

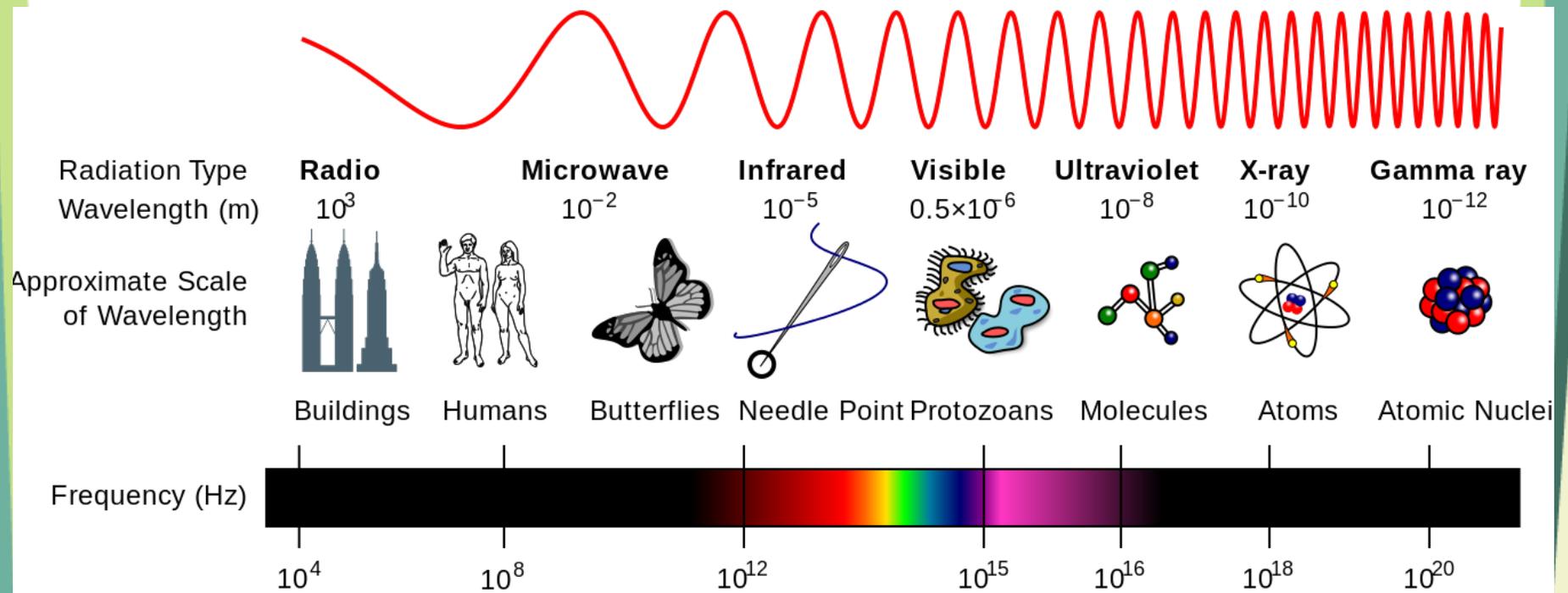


Image:

[https://en.wikipedia.org/wiki/Electromagnetic\\_spectrum#/media/File:EM\\_Spectrum\\_Properties\\_edit.svg](https://en.wikipedia.org/wiki/Electromagnetic_spectrum#/media/File:EM_Spectrum_Properties_edit.svg)

# Visible light

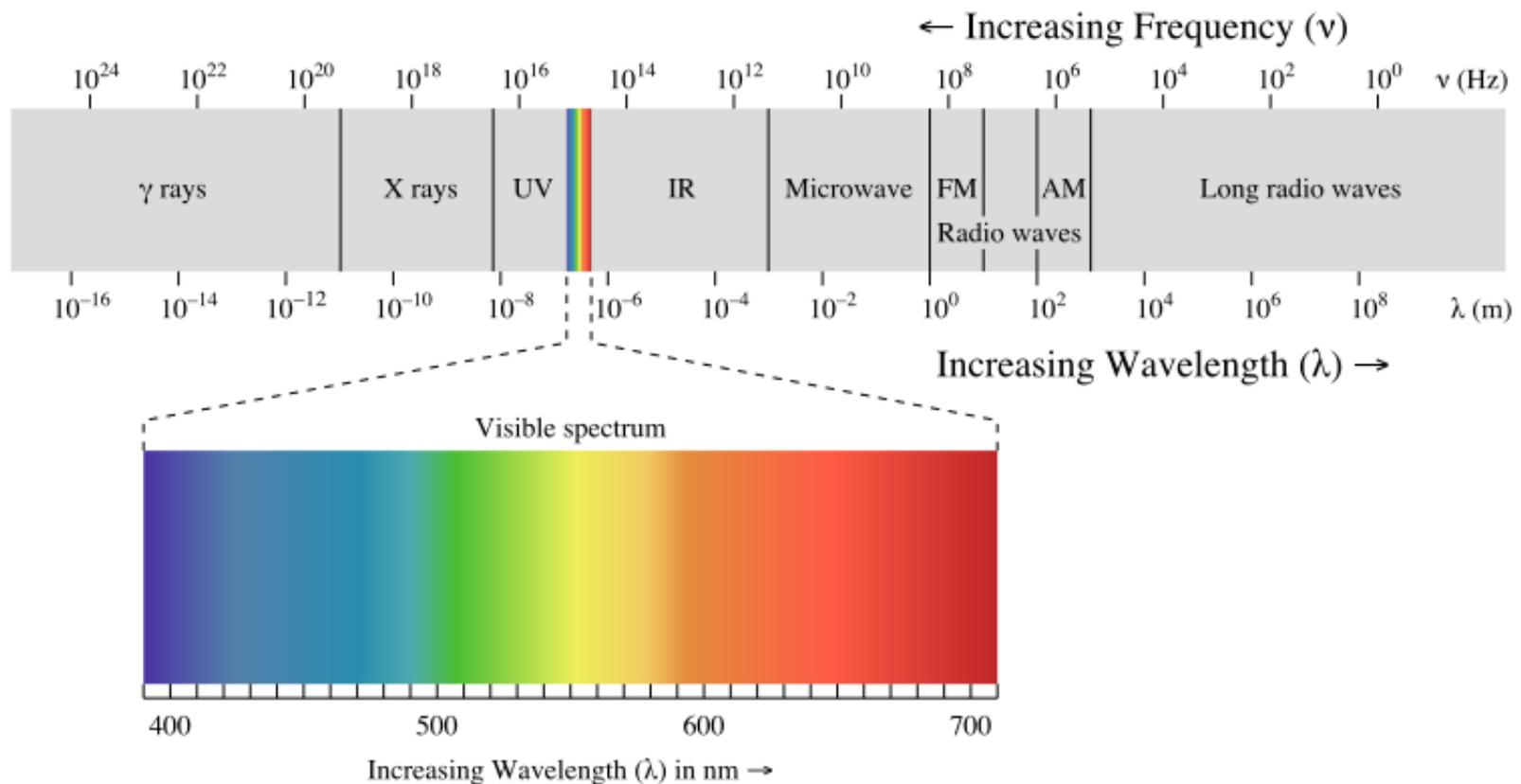


Image: [https://commons.wikimedia.org/wiki/File:EM\\_spectrum.svg](https://commons.wikimedia.org/wiki/File:EM_spectrum.svg)

# 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

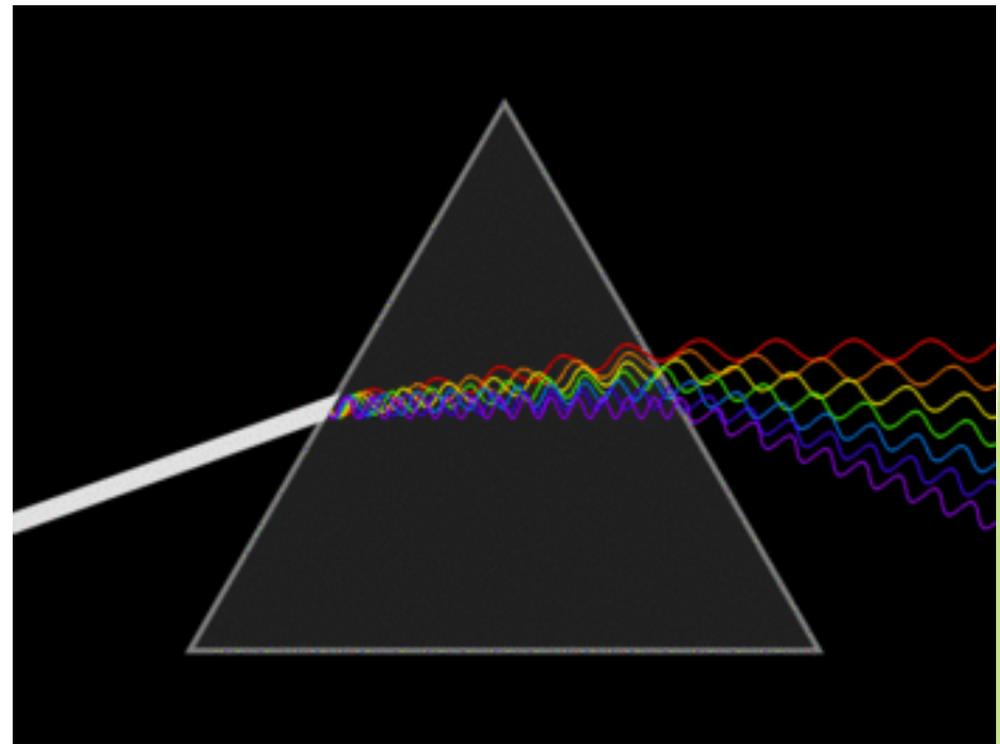
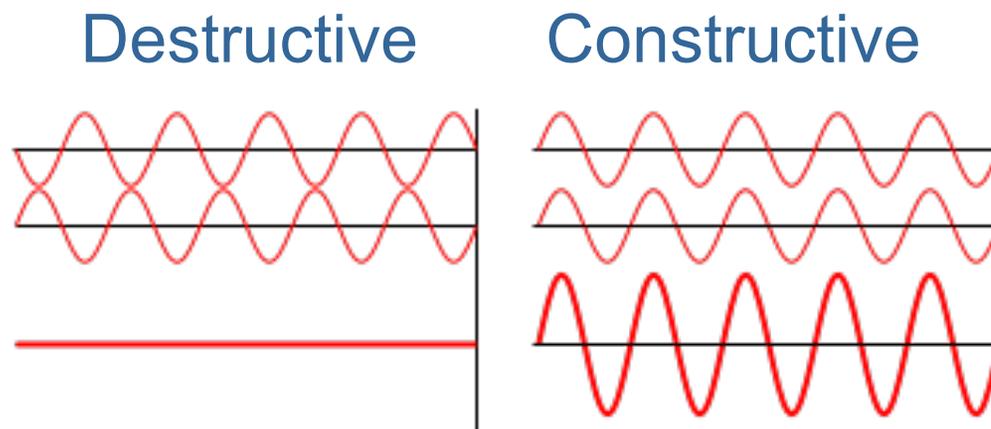


Image: [https://commons.wikimedia.org/wiki/File:Light\\_dispersion\\_conceptual\\_waves350px.gif](https://commons.wikimedia.org/wiki/File:Light_dispersion_conceptual_waves350px.gif)

# Grating can also spread light

- \* Diffraction happens because a wave adds constructively or destructively

These two waves  
adds to  
this



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](https://en.wikipedia.org/wiki/Diffraction_grating)

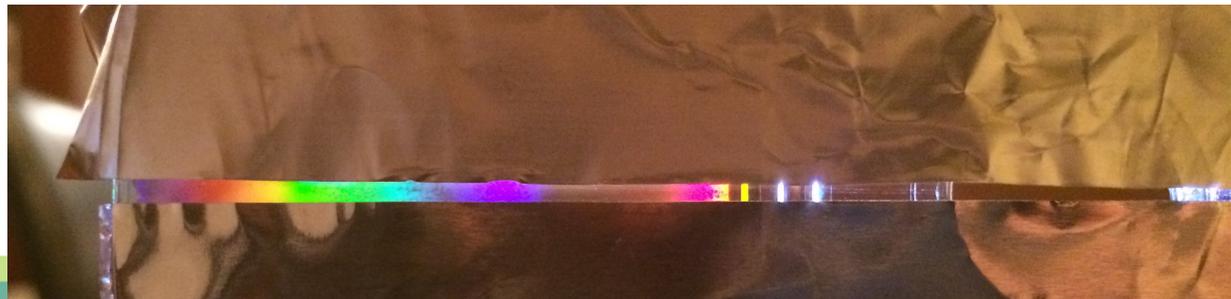
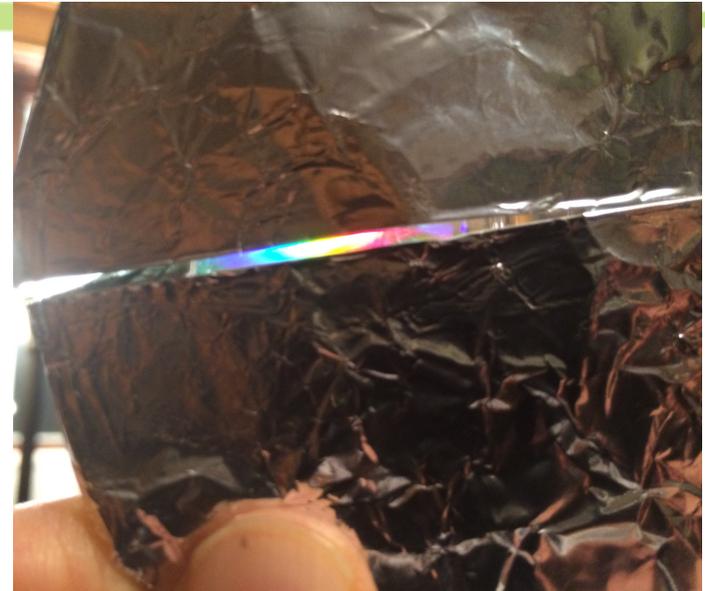
# Activity 3: Handmade Spectroscope

- \* 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?



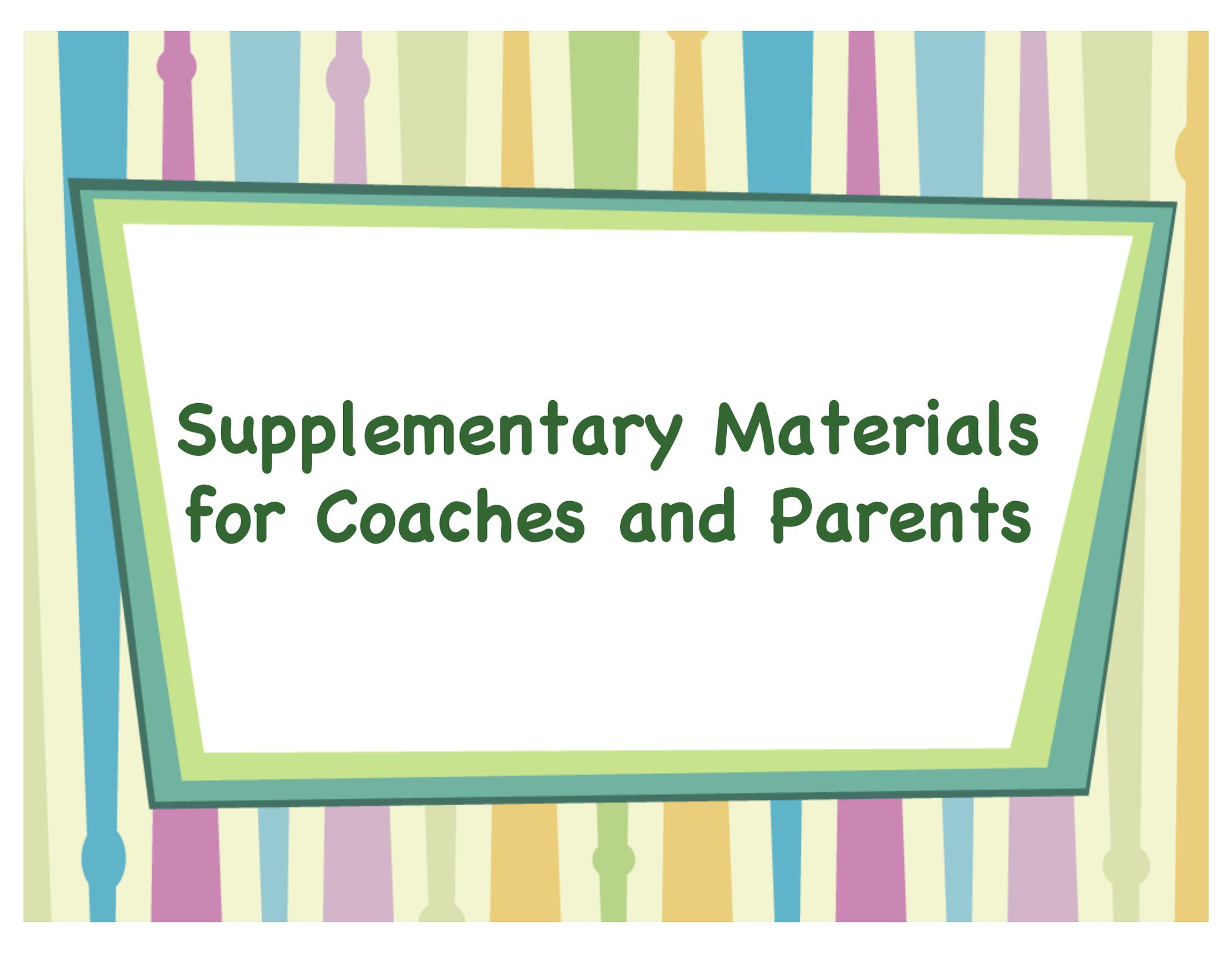
# Take-away...

- \* 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  $\sim 400\text{nm}$  to  $\sim 700\text{ nm}$
- \* 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**