TeachEngineering

STEM Curriculum for K-12

What is a Wave?

What kind of waves can you think of?

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Y/s1600/forces_of_nature_landscape_nature_ocean_w
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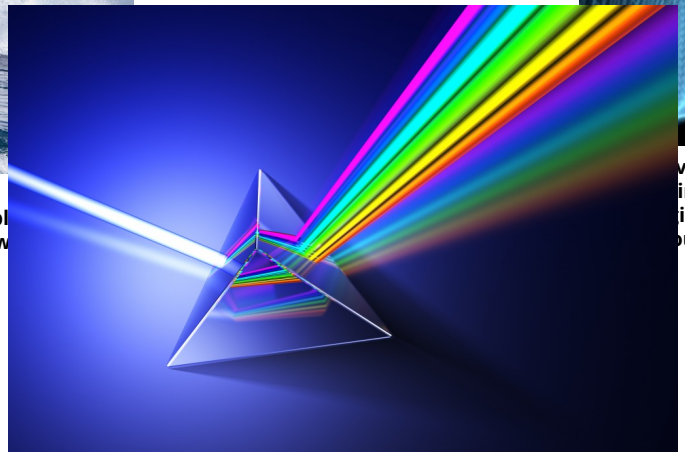
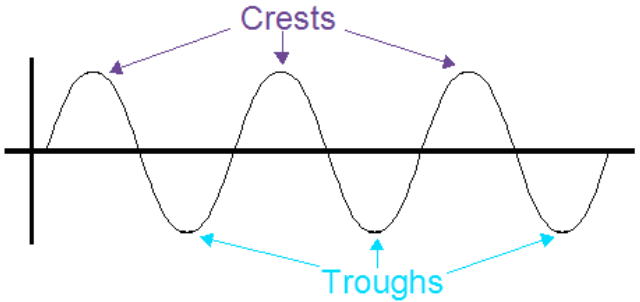
our-audio-to-432-hz.png



https://stephybonillatok.files.wordpress.com/2015/03/visualizing-the-future-prism-decomposes-lightwaves.jpg

What is a wave?

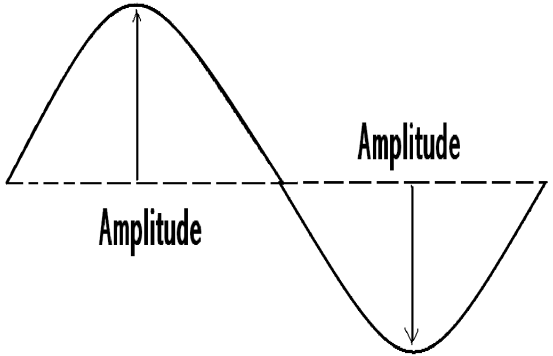
- **A wave can be defined as a disturbance in a field that carries energy through space**
- **Waves oscillate, or move back and forth between a minimum and maximum value, as they move through space**
    - **We call the minimum value the trough of the wave, and the maximum value the crest of the wave**



http://www.studyphysics.ca/newnotes/20/unit03_mechanicalwaves/chp141516_waves/images/crest_trough.png

Wave Properties

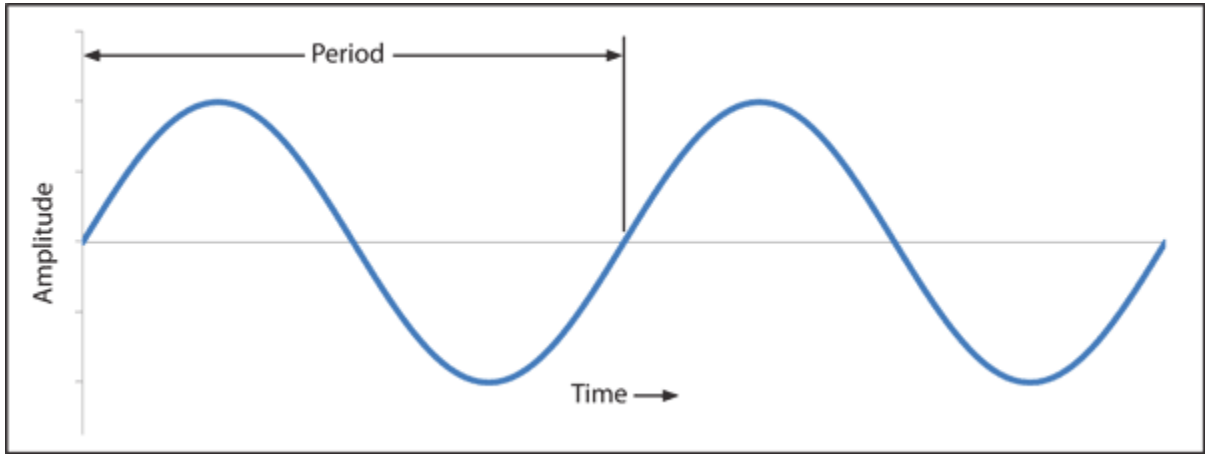
- **The amplitude of a wave is the distance between the wave's midpoint and the crest OR trough**
  - **The midpoint of the wave is also called the inflection point**
  - **The volume of a sound depends on amplitude (high = loud, low = soft)**



http://4.bp.blogspot.com/-dETtLtPvR7A/TsOl875kCTI/AAAAAAAAABk/efHhzq272rE/s1600/waveamplitude.GIF

Wave Properties

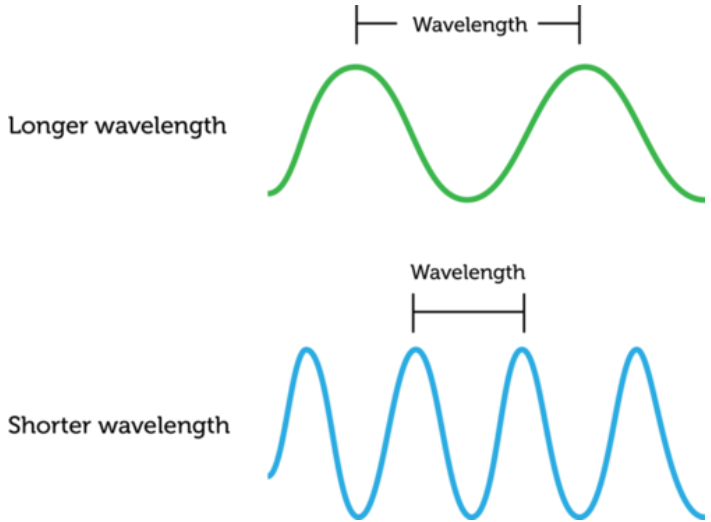
- The period of the wave is the time it takes for two consecutive crests (or troughs) to pass a specified point



https://www.minelab.com/__files/i/5890/Period.gif

Wave Properties

- **The wavelength of a wave is the distance traveled by a wave in one period**

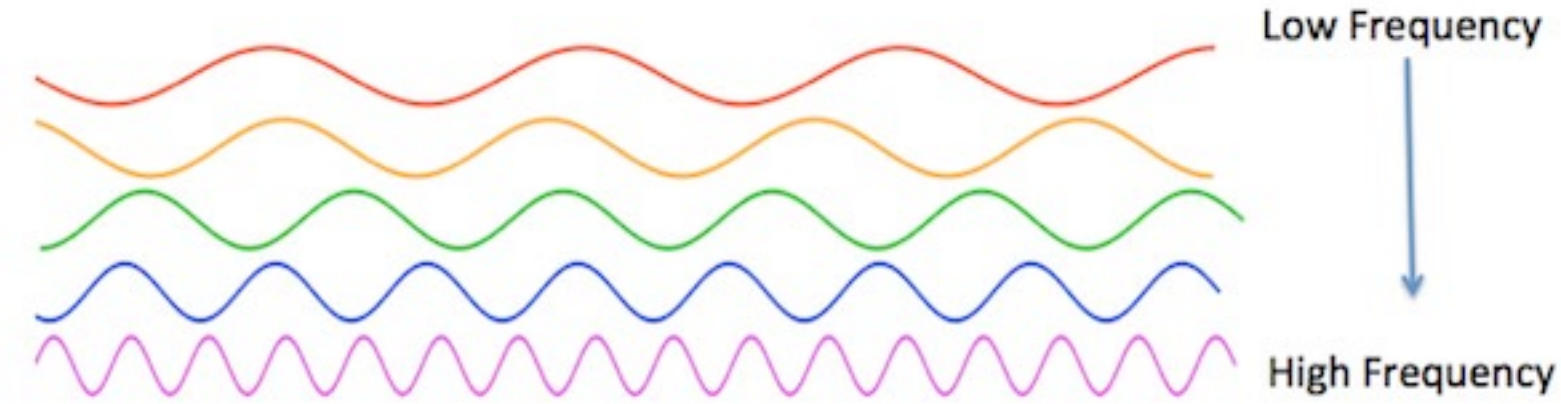


https://dr282zn36sxxg.cloudfront.net/datastreams/f-d%3A9be4ba485ea614d0eb43f8491065be2f21035f07948ad356ed82cb15%2BIMAGE_THUMB_POSTCARD%2BIMAGE_THUMB_POSTCARD.1

Wave Properties

- **The frequency of the wave is the number of full waves (crest and trough) that occur per second**
  - $f = \frac{\lambda}{t}$, **where λ is the wavelength and t is time in seconds**
  - **Frequency is measured in units of Hertz (inverse seconds)**
  - **The color of visible light depends on frequency (high = purple, low = red)**
  - **The pitch of sound depends on frequency (high = high pitch, low = low pitch)**

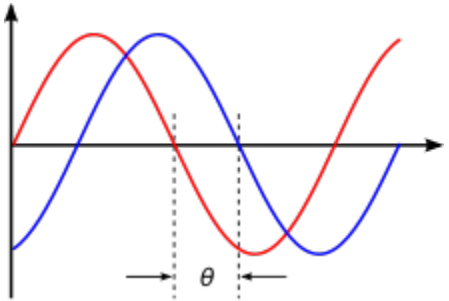
Wave Properties



https://study.com/cimages/multimages/16/wavefrequency.png

Wave Properties

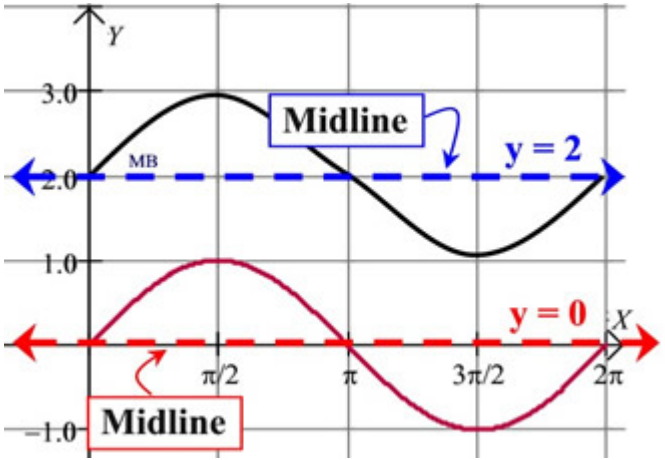
- The phase angle of the wave shifts the wave to the left or right on the x-axis
  - A negative phase angle will shift the wave to the right
  - A positive phase angle will shift the wave to the left



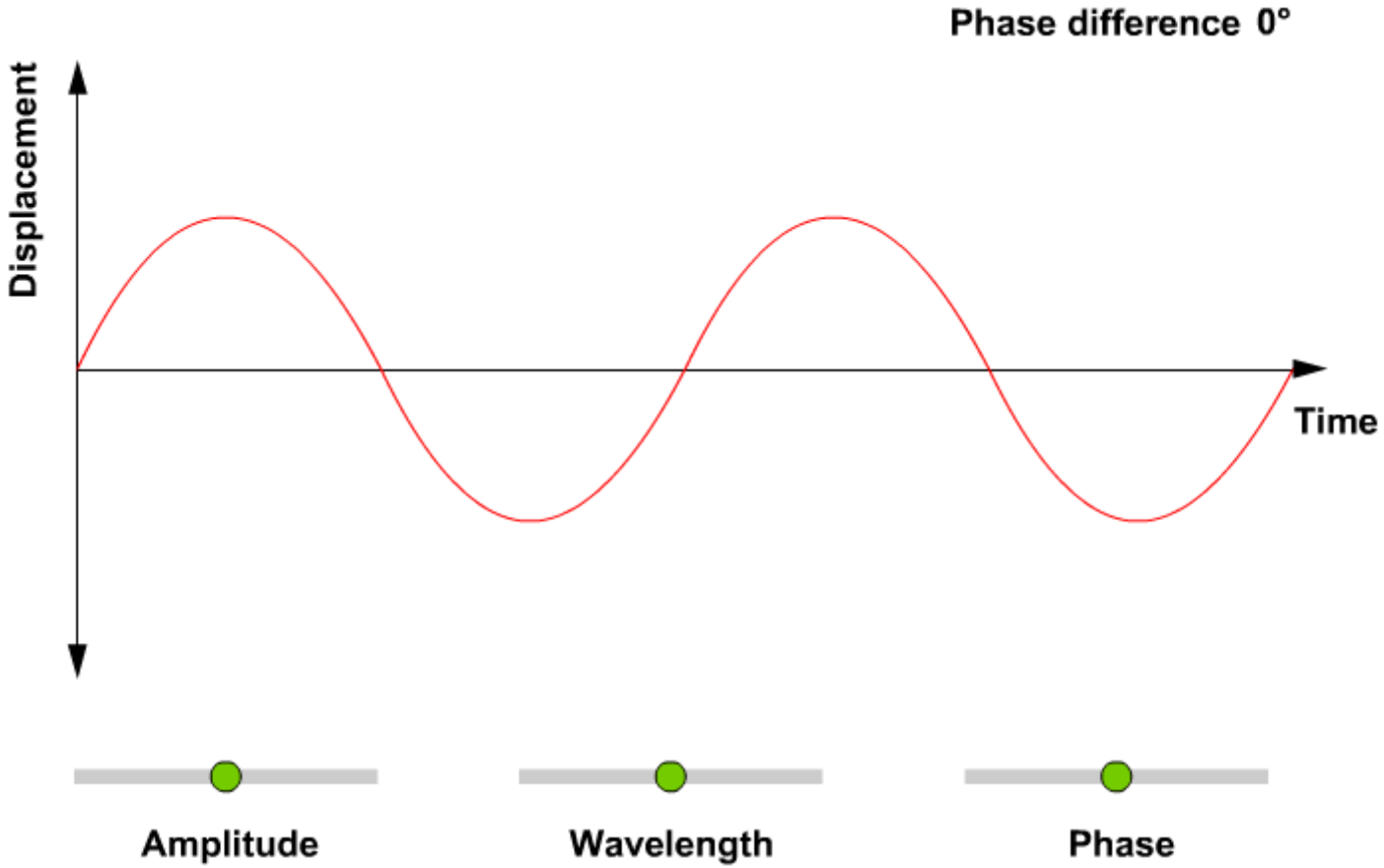
https://upload.wikimedia.org/wikipedia/commons/thumb/5/55/Phase_shift.svg/220px-Phase_shift.svg.png

Wave Properties

- A wave may be shifted up or down the y-axis by using a vertical shift
  - A negative vertical shift will move the wave down the y-axis
  - A positive vertical shift will move the wave up the y-axis



https://mathbitsnotebook.com/Algebra2/TrigGraphs/midline.jpg


Phase difference 0°
Displacement
Time
Amplitude
Wavelength
Phase

Mathematical Model of a Sine Wave

- **We can model a wave using a sine wave, or sinusoid: a curve that has a smooth, repetitive oscillation**

$$y(t) = Asin(2\pi ft + \theta) + v$$

Where:

- **A is the amplitude of the wave**
- **f is the frequency of the wave**
- **t is time in seconds**
- **θ is the phase angle of the wave (in radians)**
- **v is the vertical shift of the wave**

Note on Radians and Degrees

- **Because our equation of a sine wave involves using an angle in radians, it is helpful to know the following conversion between degrees and radians:**

$$\theta = \frac{\pi}{180} * (angle\ in\ degrees)$$