What is a Wave?
What kind of waves can you think of?

- Ocean waves
- Sound waves
- Light waves
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.

![Diagram of waves with crests and troughs](http://www.studyphysics.ca/newnotes/20/unit03_mechanicalwaves/chi41516_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)
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
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 \( \lambda \) 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.png
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

\[ y(t) = A \sin(2\pi ft + \theta) + v \]

Where:

- \( A \) is the amplitude of the wave
- \( f \) is the frequency of the wave
- \( t \) is time in seconds
- \( \theta \) 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:

\[
\theta = \frac{\pi}{180} \times (\text{angle in degrees})
\]