Waves: An Intro

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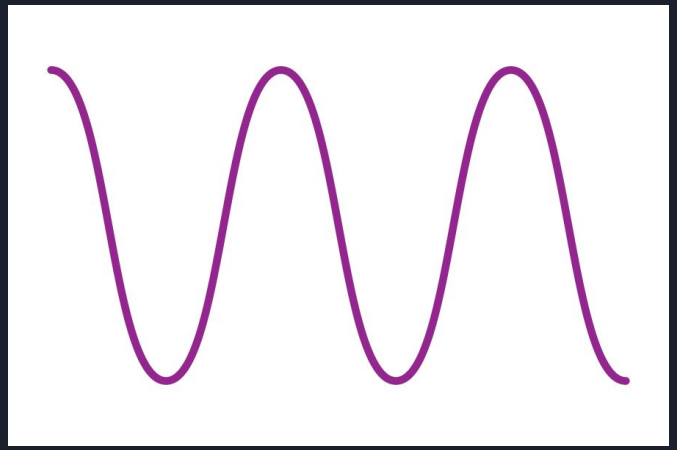
What is a wave?

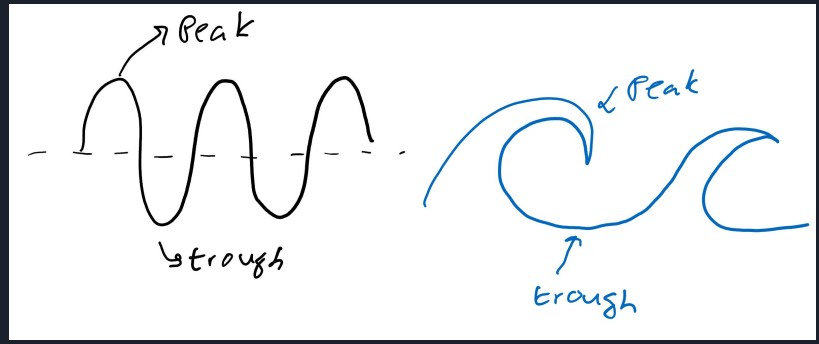
What is a Wave?

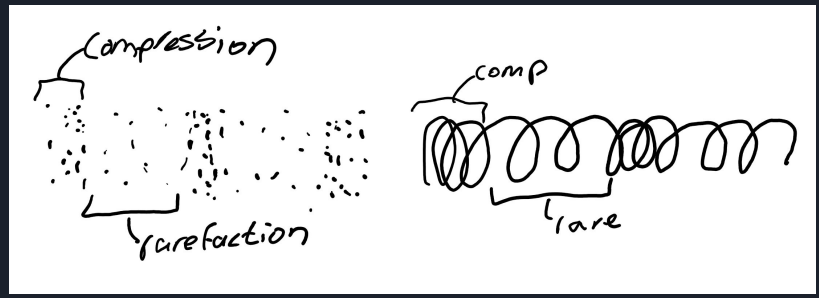
- Waves: Waves transport energy without the transfer of matter. But what does that mean?
- What are some types of waves?
- There are a lot:



What does a wave look like?

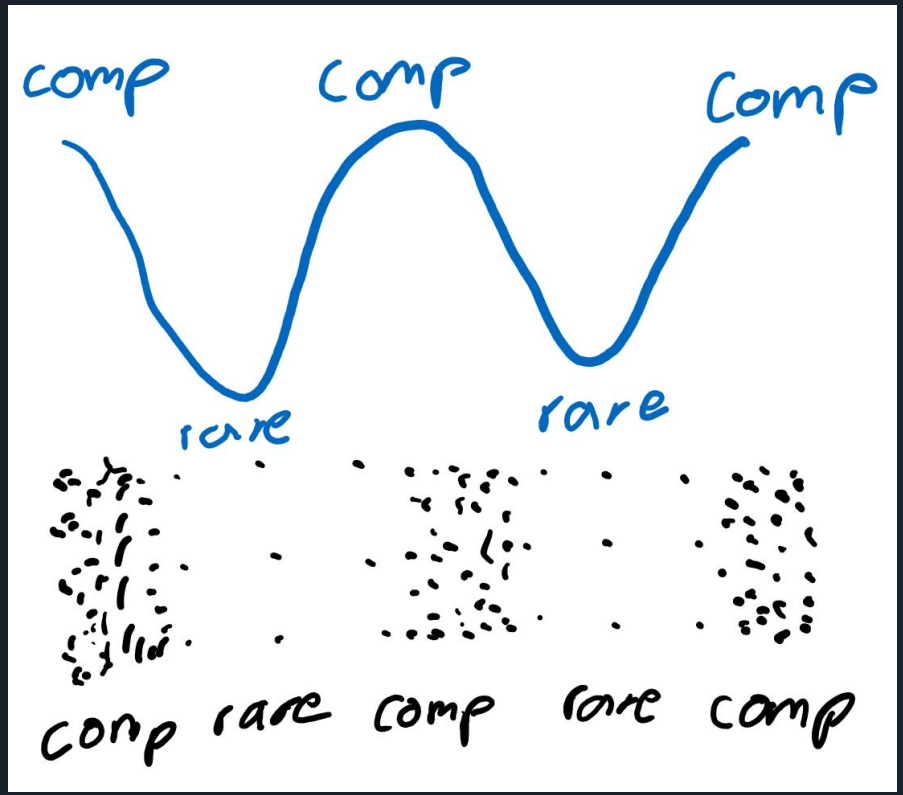
- Transverse waves
  - They do the up and down
  - Vroom, drop, vroom, drop, etc.
- Longitudinal waves
  - They do the back and forth
  - Squish, unsquish, squish, unsquish, etc.





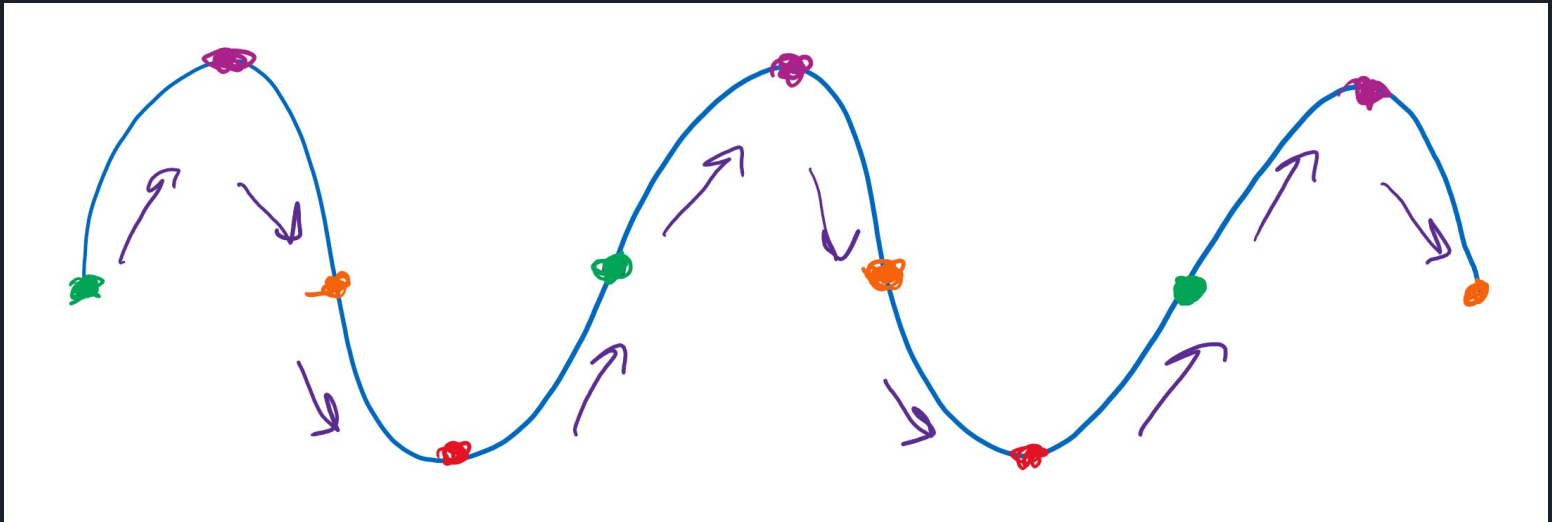
Expressing longitudinal waves

- Compressions and rarefactions are hard to show on paper
- We can draw longitudinal waves in a way similar to transverse waves!



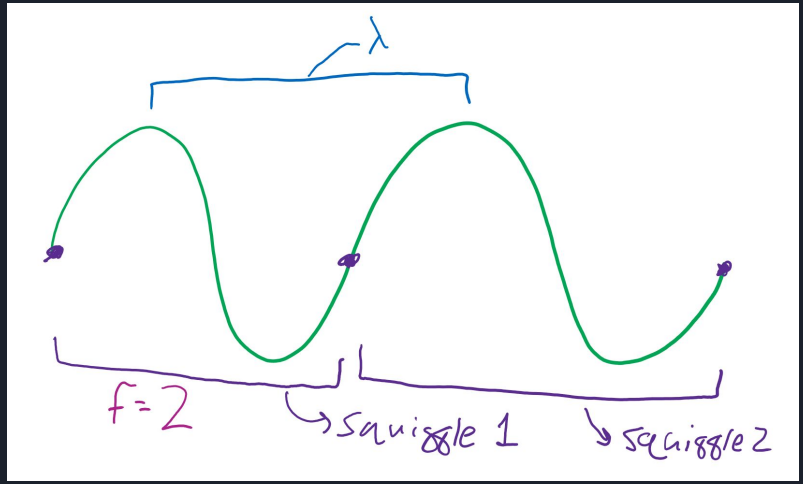
What is a “squiggle?”

A squiggle (cycle) is the segment from the same color to the next same color (aka, red to red or orange to orange to orange). After one cycle the next cycle looks the exact same. Repeat repeat repeat.



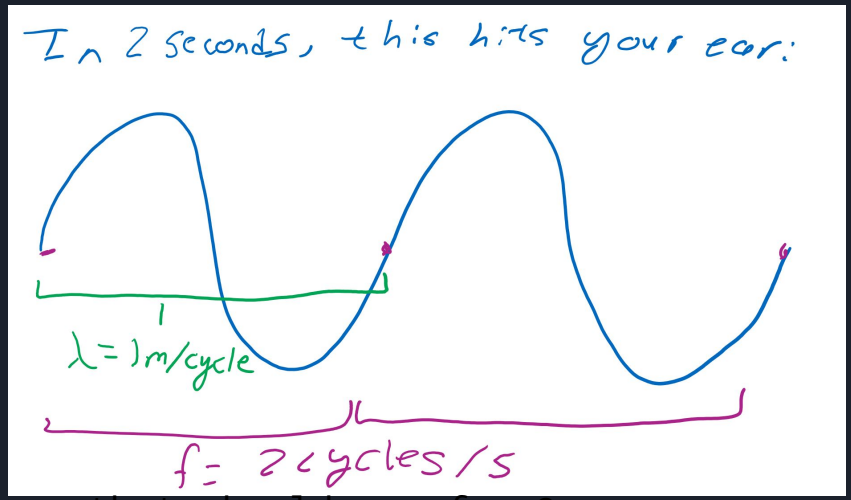
Frequency and wavelength

- Frequency (f): number of squiggles per second. Measured in “hertz.” Units for “hertz” is 1/s.
- Wavelength (λ): length of squiggle. Measured in meters.



More about the two

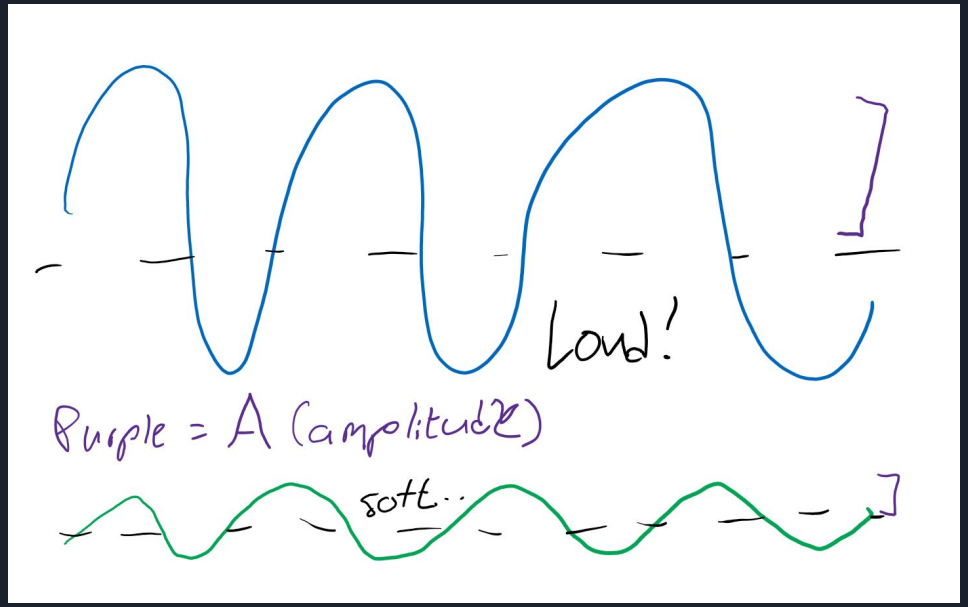
- Wavelength
  - Measured as the distance between peaks or distance between troughs.
  - Also the length of a cycle.
- Frequency
  - How many cycles occur in a given time
  - # of cycles divided by time.



*that should say f = 2 cycles / 2 seconds

Energy (amplitude)

- Amplitude
  - How “tall” a wave looks
  - Determine the “strength” of the wave
  - High amplitude sound waves are loud
  - High amplitude light waves are “bright”



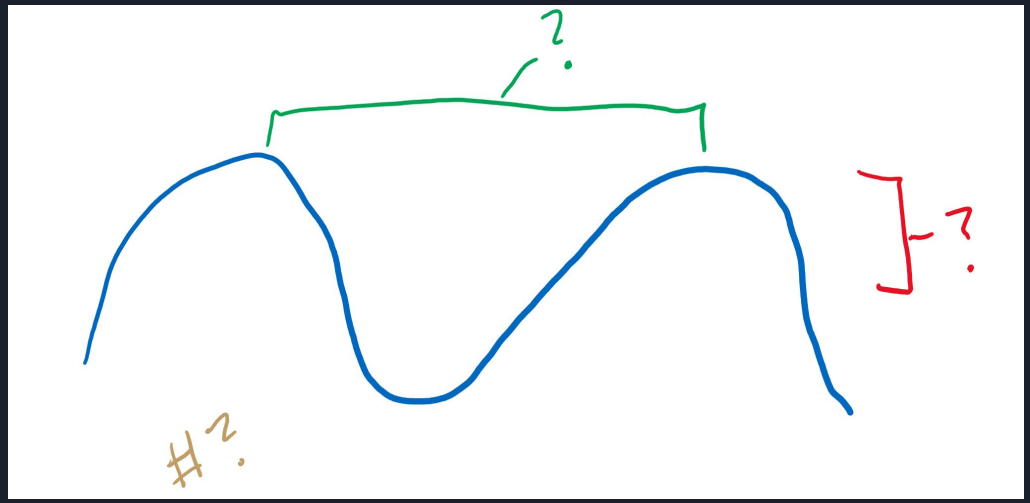
Review

What are some waves you know?

What is wavelength?

Frequency?

Amplitude?

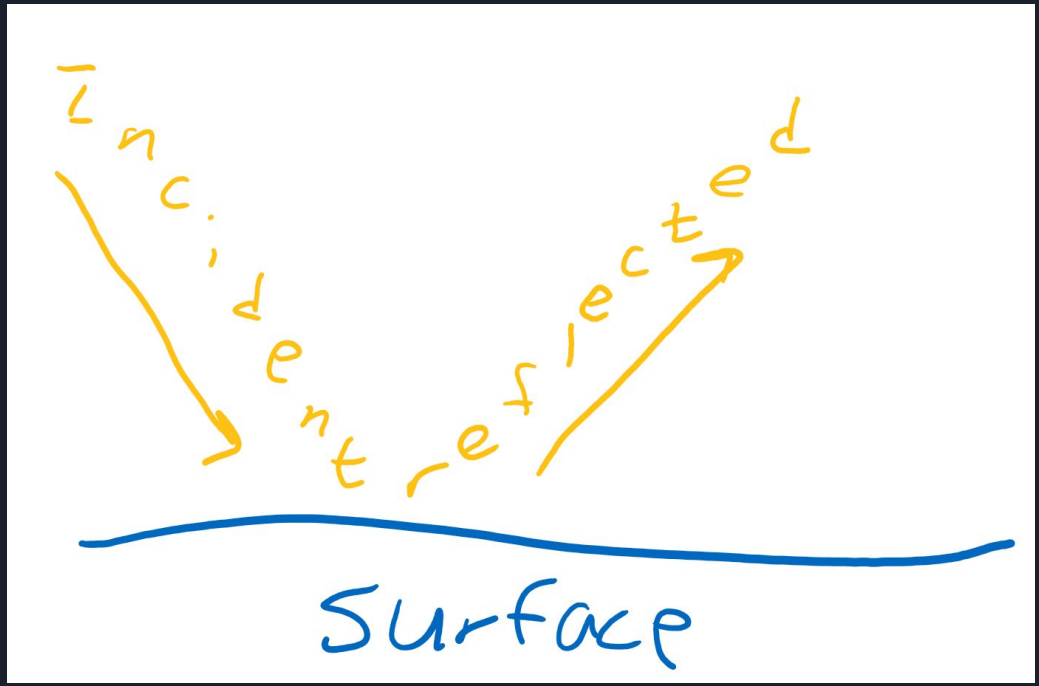


Reflection

Where do we see reflection?

Naming the things

- Surface:
  - The thing that does the reflecting
- Incident:
  - Refers to the wave before it gets reflected
- Reflected:
  - Refers to the wave after the reflection



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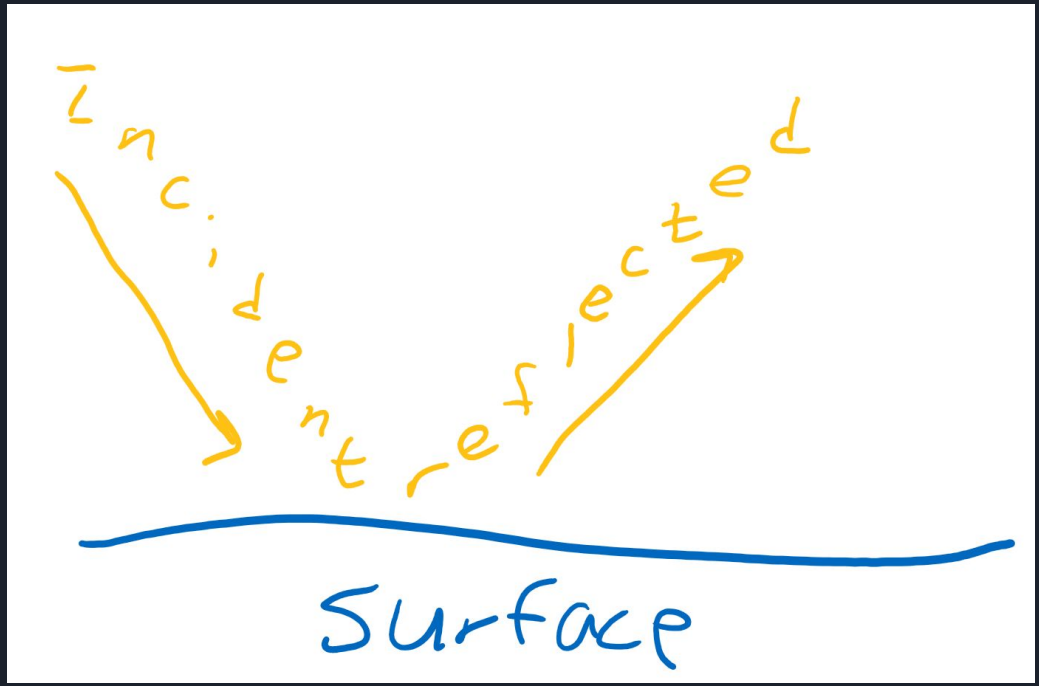
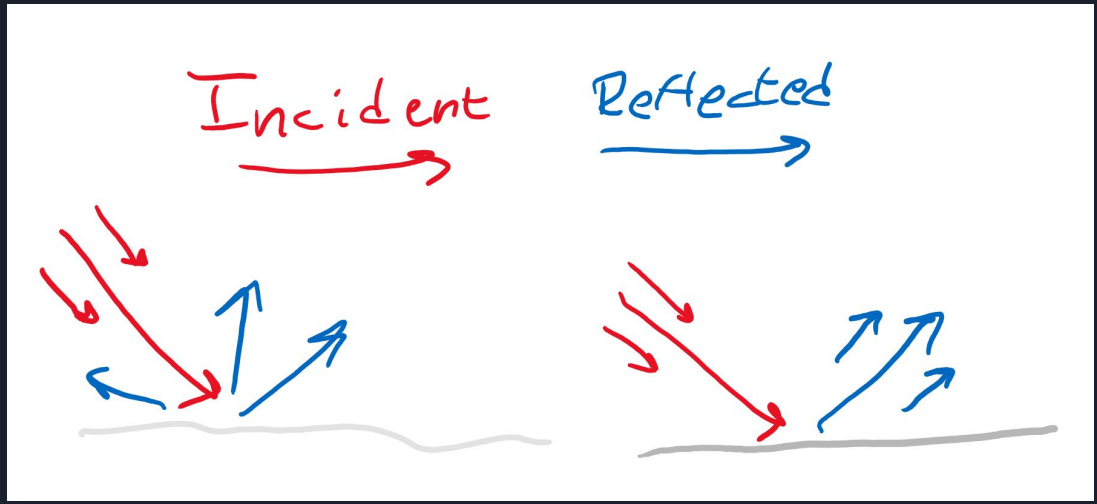


Types of surfaces

- Diffuse reflector:
  - Waves bounce everywhere
  - No set direction
- Specular reflector:
  - Special rules
  - Bounce in orderly fashion



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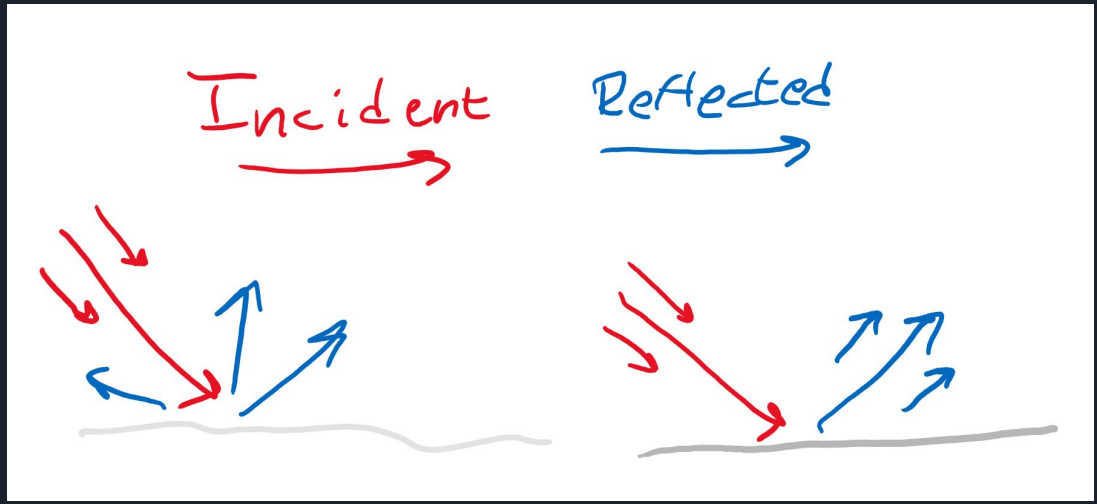
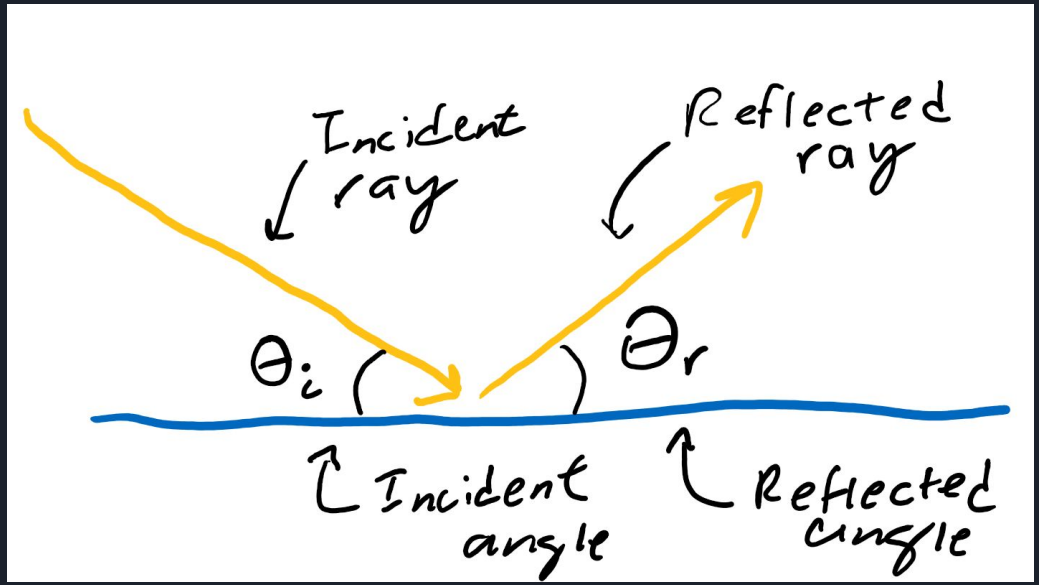


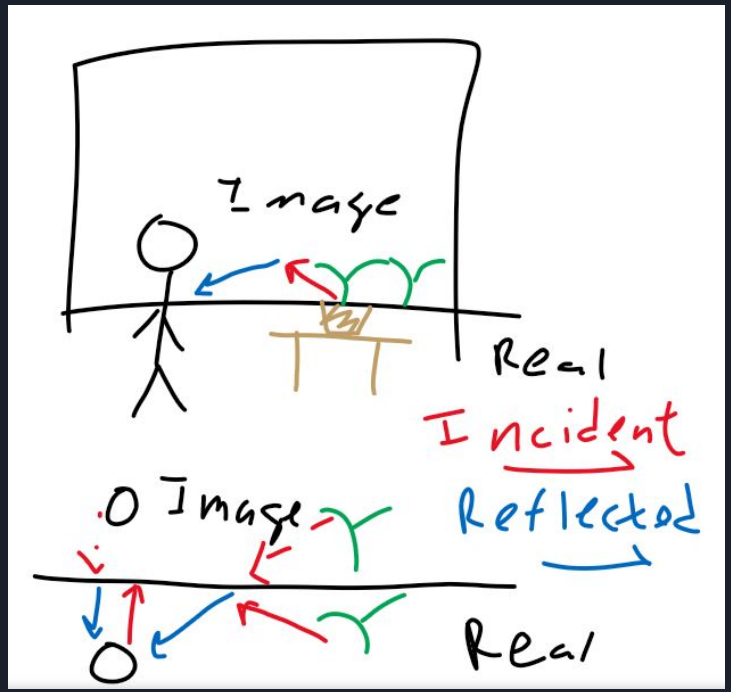
Doing the math (specular reflectors)

- Angle of incidence
  - The angle at which the wave comes in
- Angle of reflection
  - The angle at which the wave goes out at
- These two angles are equal in measure



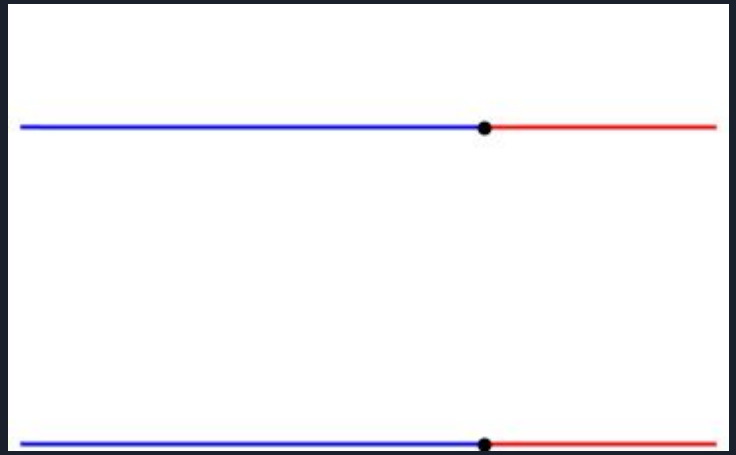
The “image”

- On a flat mirror, the image (or the thing we see reflected in the mirror) is always opposite of the actual object
- The distance from the original/real object to the mirror is the same as that from the image to the mirror



What actually happens to the wave

- Fixed end
  - Like a rope tied tight on a post
  - The wave “flips”
  - Mirrors
- Free end
  - Like a rope sliding on a post
  - The wave just “comes back” at us



Parabolic reflectors

- Parabolic
  - Reflect parallel rays into a certain point and vice versa
  - Spotlights shoot light in one direction
  - Antennae use them to reposition waves into the receiver
- Spherical
  - Parabolic is hard to make, so spheres are used to approximate a parabolic reflector

Review

What is reflection?

What kinds of “reflectors” are there?

If I come in at an incident angle of 90 degrees, what’s my reflected angle?

On a flat mirror, where is the image?

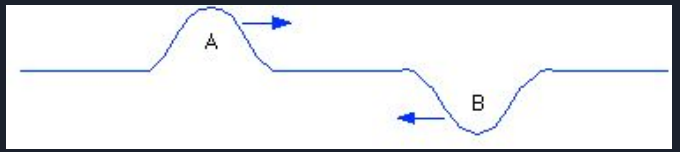
What are some special types of mirrors?

Interference

What is Interference?

In essence, it’s when waves interact with other waves

What will happen when the 2 sets of waves below collide?



2 Pebbles in a Lake

Waves are not all just single bumps

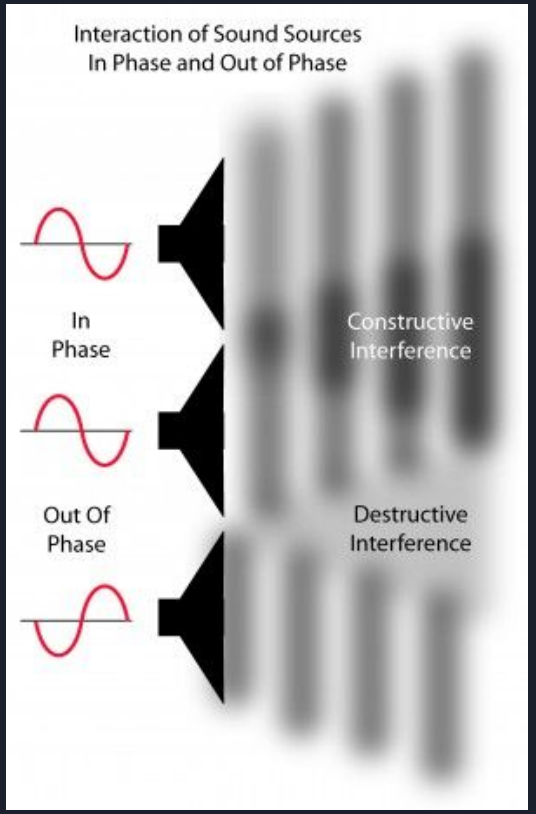
- Repeated Ups and Downs
- Many points of Addition and Subtraction

Constructive Interference

When waves add together

- Amplitudes add, volume increases
- The height of the wave increases

What happens with longitudinal waves?

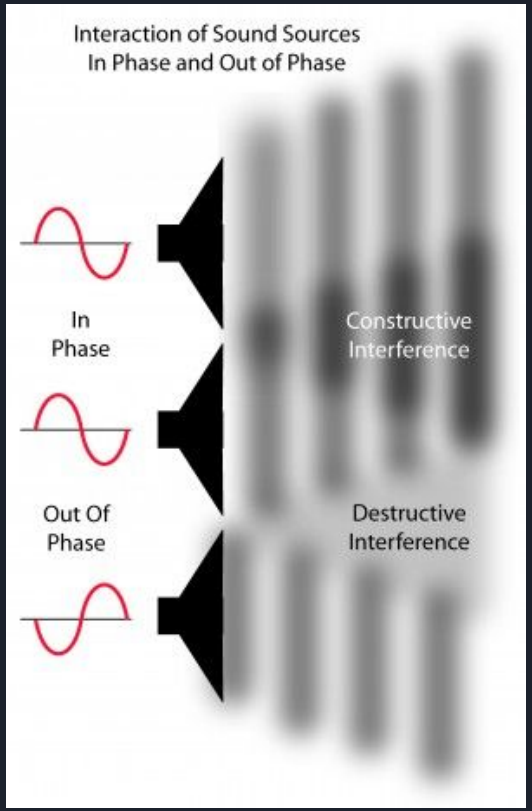


Destructive Interference

When to opposite waves “add” to each other

- Amplitude drops/goes to 0
- Creates a softer tone

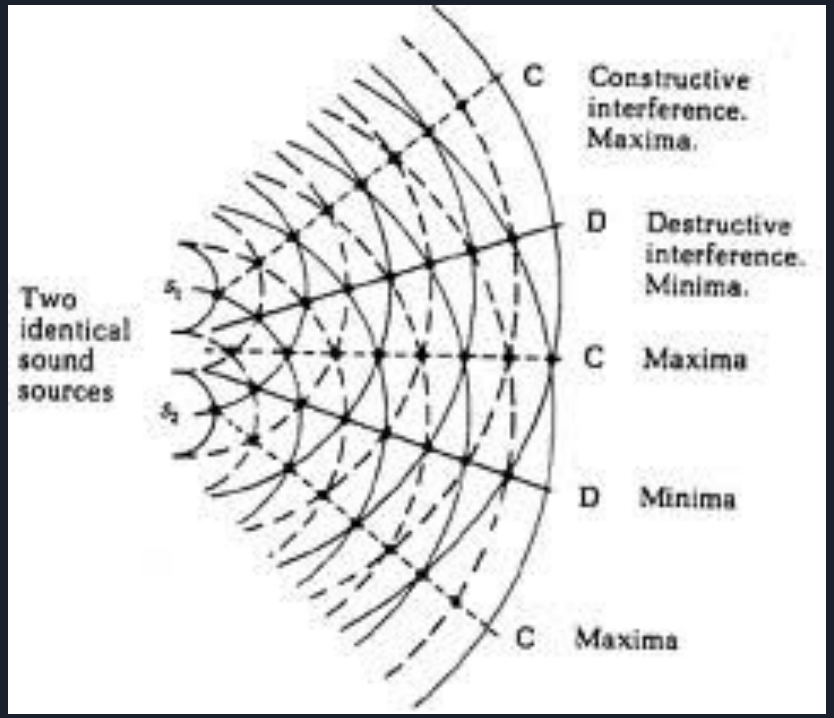
What happens with Longitudinal waves?



On a Larger Scale

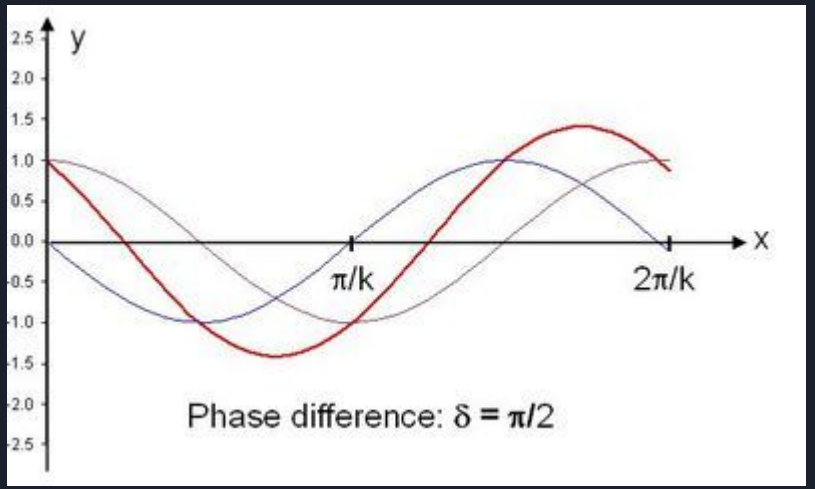
Consider the 2 sources

What happens as you travel along in the room?



In Phase and Out of Phase

- In Phase: Perfect Constructive Interference
- Out of Phase: Perfect Destructive Interference
- Somewhere in Between:
- 90 Degrees out of phase

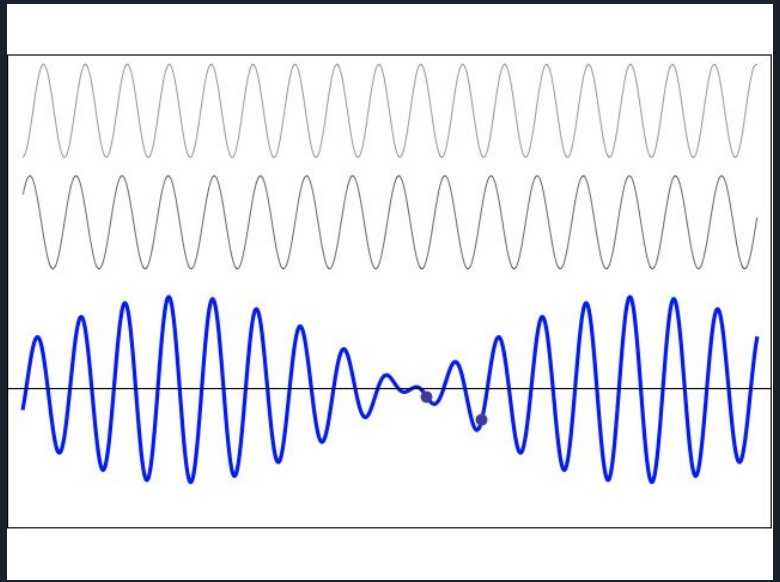


When Waves have Differing Frequencies

So far, we've only seen waves with the same frequency

What if they are different?

- Constructively interferes at some points
- Destructively interferes at others
- Music?



Review

What is interference?

What is the difference between Constructive and Destructive interference?

What does it mean for 2 waves to be 180 degrees out of phase?

What happens when different frequencies interfere with each other?