## Bell Ringer

1. Draw a picture of a wave and label wavelength and amplitude.

## Waves



## What is a wave?

A wave is simply energy moving from one place to another.
It always needs something to move through
Example:


Sound is the wave and the air is the medium


## Wave Anatomy

Crest
Wavelength $=$ symbol: $\lambda \quad$ Units: meters $(m)$


Amplitude $=$ symbol: $A \quad$ Units: meters ( $m$ )

## Period

Answer to the question: How long does it take to happen once?

$$
T=\frac{\text { time }}{\# \text { of cycles }}
$$

The amount of time it takes to complete one cycle, or the time equivalent of one wavelength
Symbol = T Units $=$ seconds $(\mathrm{s})$


## Springs/pendulums as waves



- https://www.youtube.com/watch?v=7 AiV12XBbI


## Erequency

$$
f=\frac{\# \text { of cycles }}{\text { time }}
$$

Answer to the question:
How many times does this happen per second?
The number of cycles (or wavelengths) that occur in one second of time
Symbol $=\mathrm{f} \quad$ Unit $=$ hertz $(\mathrm{hz})$ or (cycles per second)


## Practice

Jimmy is counting the passing waves of a struggling Jane.... If Jimmy sees 6 waves every 5 seconds, what is the frequency of the waves?

Frequency is the number of waves per second Do 6 waves every 5 seconds is $6 / 5=1.2 \mathrm{hz}$

## Wave Speed

The speed at which a waves moves through space

$$
v=\frac{d}{t}
$$

$$
v=\lambda / T=\lambda * f
$$

## Units $=\mathrm{m} / \mathrm{s}$



## Practice

The limit of human hearing is 20 hz to $20,000 \mathrm{hz}$. If the speed of sound is around $340 \mathrm{~m} / \mathrm{s}$, what is that range in wavelengths?

$$
v=\lambda * f
$$

$$
340=\lambda * 20 \quad 340=\lambda * 20000
$$

$$
\lambda=17 m \quad \lambda=0.017 m
$$

## Transverse Waves

Particle motion is perpendicular to the motion of the wave

Wave moves forward and the particles move up and down

Transverse Wave


## Longitudinal waves

Particles move in the same direction as the wave

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## Longitudinal Waves

Compressions


NOTE: "Cl stands for compression and "R" stands for ranefaction

## Practice

Measure the wavelength, amplitude, period, frequency and velocity of the following waves:


| I | 1 | 1 |  | 1 | 1 |  | 1 | 1 |  | 1 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |



$$
\mathrm{f}=1 / \mathrm{T}=1 / 4.8=0.208 \mathrm{hz}
$$



## Properties of Waves



Compression Expansion


Longitudinal wave $\leftarrow$ Wavelength $\longrightarrow$

## Wave Interference

What happens when two waves run into each other?

## They interfere in two different ways:

Constructive Interference:

The amplitudes of the waves add together because they are in phase


Destructive Interference:

The amplitudes of the waves subtract because the waves are out of phase


Wave on a string

## Superposition of Waves



## Standing waves

When a wave interferes with itself setting up a pattern of constructive and destructive interference

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- https://www.youtube.com/watch?v=wYoxOJDrZzw
- https://www.youtube.com/watch?v=NpEevfOU4Z8
- Wave on a string
- Slinky


## Reflection <br> When a wave bounces back because of an encounter with another medium.

| When a wave encounters |
| :--- |
| a rigid barrier it will |
| reflect back out of phase |

## When a wave encounters a loose barrier will reflect back in phase

When a wave encounters a barrier of different density some of it will TRANSMIT and some of it will REFLECT

Wave on a string

## Bell Ringer

- Microwaves have a frequency of $300 \times 10^{\wedge} 6 \mathrm{~Hz}$. If the speed of light is $3 \times 10^{\wedge} 8 \mathrm{~m} / \mathrm{s}$, what is the wavelength of a microwave?
- X-rays have a wavelength of $1 \times 10^{\wedge}-9$ meters. What is their frequency?


## Law of Reflection

The angle of the reflected wave will always equal the angle of the incident (approaching) wave.


## One-way mirrors

- https://www.youtube.com/watch?v=4kKL320pewI


## Practice

How far back from the mirror does Jimmy need to move in order for him to see his entire reflection?


He'll NEVER be able to see his whole self..... Unless he buys a bigger mirror!

## Refraction

## When a wave bends (slows down) because of a change in medium.




https://www.youtube.com/watch?v=EtsXgO
DHMWk

## $n_{1} \sin \left(\theta_{1}\right)=n_{2} \sin \left(\theta_{2}\right)$

## Snell's Law

## n is the index of refraction



| $\left(f=5.09 \times 10^{14} \mathrm{~Hz}\right.$ |  |
| ---: | ---: |
| or |  |
| $\left.\lambda=5.9 \times 10^{-7} \mathrm{~m}\right)$ |  |
| Air | 1.00 |
| Canada Balsam | 1.53 |
| Corn oil | 1.47 |
| Diamond | 2.42 |
| Ethyl alcohol | 1.36 |
| Glass, crown | 1.52 |
| Glass, flint | 1.66 |
| Glycerol | 1.47 |
| Lucite | 1.50 |
| Quartz, fused | 1.46 |
| Sodium chloride | 1.54 |
| Water | 1.33 |
| Zircon | 1.92 |

## Practice

Jane is shooting a Laser at Jimmy who she has encased in a sheet of glass. What does the index of refraction of the glass need to be so that she can slow roast Jimmy?


# Diffraction 

The tendency of waves to bend around corners and fill spaces.



## Double Slit Diffraction

 the slits!!!

[^0]
[^0]:    https://www.youtube.com/watch?v=Iuv6hY 6zsdo

