Standing Waves

**Reflection**

Occurs when a wave strikes a medium boundary and \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ into original medium

Completely reflected waves have the same \_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_ as the original wave

**Interference**

When two waves \_\_\_\_\_\_\_\_\_, they don’t bounce or stick like objects do, they \_\_\_\_\_\_\_\_\_\_\_

This means they form \_\_\_\_\_\_ wave for a moment and then continue on \_\_\_\_\_\_\_\_\_\_\_

The total amplitude of the waves is equal to…

Two waves with the same frequency and opposite phase.

**Destructive Interference:**

Two waves with the same frequency and phase. **Constructive Interference:**

Waves can have constructive and destructive interference at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Standing Waves**

* When a wave hits a fixed boundary it will \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_ its amplitude.
* If a series of waves are sent along a string the reflected pulse will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with the next pulse
* If the waves are sent at just the right frequency we will create a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Areas of complete destructive interference have \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and are called \_\_\_\_\_\_\_\_\_\_
* Areas of complete constructive interference have \_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and are called \_\_\_\_\_\_\_\_\_\_

**Harmonics**

- Musical instruments vibrate in such a way that a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pattern results

- These patterns are only created within the instrument at specific \_\_\_\_\_\_\_\_\_\_\_\_\_ of vibration; these frequencies are known as harmonic frequencies, or merely **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

- The first frequency is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ – it determines the \_\_\_\_\_\_\_\_\_\_\_

- The higher harmonics are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Harmonics – closed at one end, open at one end**

- Pipes that are open at one end have an antinode at one end and a node at the other.

- Each sound you hear will occur when an ***\_\_\_\_\_\_\_\_\_\_***appears at the top of the pipe.

- You get your first sound or

 encounter your first antinode

 when the length of the actual

 pipe is equal to a \_\_\_\_\_\_\_\_\_

of a wavelength.

You have a \_\_\_\_\_\_\_ at the 2nd

harmonic position, therefore

 \_\_\_\_\_ sound is heard

You have an \_\_\_\_\_\_\_\_\_\_\_\_\_ at the 3rd harmonic position, therefore \_\_\_\_\_\_\_\_\_\_ is produced.

Sounds in pipes with one open end are produced only at \_\_\_\_\_\_ harmonics

- Sounds in open or fixed end pipes are produced at \_\_\_\_\_\_\_ harmonics

**Harmonics – 2 open ends or 2 fixed ends**

- Sounds are heard for 2 fixed ends when a \_\_\_\_\_\_ is at the end, they are heard in 2 open ends when an \_\_\_\_\_\_\_\_\_\_\_\_\_ is at the end.

- In both cases, this first occurs at \_\_\_\_\_\_\_\_\_ of a wavelength. This is called the fundamental frequency.

 2 open ends 2 fixed ends

1) The Sun is 1.50x108 km from Earth. How long does it take for the light from the Sun to reach us?







**Example**

- How long do you need to make an organ pipe (open at both ends) that produces a fundamental frequency of middle C (256 Hz)? The speed of the sound in air is 340 m/s.

b. What is the wavelength and frequency of the 2nd harmonic? Draw the standing wave

**Example**

The windpipe of a typical whooping crane is about 1.525-m long. What is the lowest resonant frequency of this pipe assuming it is a pipe closed at one end? Assume the speed of sound is 353 m/s