Unit 7: Waves **1 –Waves and Sound**

A **wave** is...

Ex.

Medium:

Crest:

Trough:

Amplitude (A):

Wavelength (λ):

There are 3 types of mechanical waves:

(1) Transverse

(2) Longitudinal

(3) Surface

Period (T):

Frequency (f):

Frequency and period are reciprocals, that is:

Ex: Playing middle C on a piano produces a sound with a frequency of 256 Hz. What is the period of the sound wave?

Ex: An air horn sounds at a frequency of 220 Hz. If the speed of sound in air is 330 m/s what is the wavelength of the sound wave?

Remember that speed is:

If we look a single wave then:

(1)

(2)

This gives us the **Universal Wave Equation**:

Where:

v =

λ =

f =

Ex: The distance between successive crests in a series of water waves is 4.0 m, and the crests travel 8.6 m in 5.0 s. Calculate the frequency of a block of wood bobbing up and down on these water waves.

Determining Max and Min Audible Frequencies:

fmin: 1000 Hz fmax: 5000 Hz

Assuming that the speed of sound in air is 343 m/s, determine the max and min wavelengths.

λmin: \_\_\_\_\_\_\_\_\_ m λmax: \_\_\_\_\_\_\_\_\_ m

Sound

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves of pressure that stimulate our ear drums
* The speed of sound depends on its \_\_\_\_\_\_\_\_\_\_\_ (more dense 🡪 \_\_\_\_\_\_\_\_\_\_)
* Pitch is determined by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Volume is determined by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The Doppler Effect

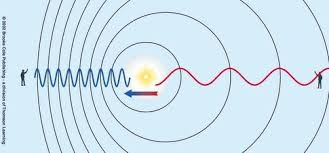
Now imagine that bug skimming along the surface of the pond.

The waves in back: The waves in front:

Imagine a water bug standing on the surface of a pond, bouncing up and down.

The Doppler Effect and Red Shift

* When we look at other galaxies we notice that their spectra (colours) are shifted towards \_\_\_\_\_\_\_\_.
* This is a result of a Doppler shift of the EM Radiation towards a \_\_\_\_\_\_\_\_\_\_\_\_\_ wavelength.
* Therefore the galaxies must be moving \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ us.
* And so the universe must be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



Calculating Doppler Shift

* When calculating the change in frequency for an observer we must consider TWO things.
* The velocity of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or the “thing” generating the wave.
* The velocity of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or the “thing” hearing the wave.

The change in frequency is given by the equation: 

where:

*f* = observed frequency

*f*o = frequency of the original wave

 = velocity of the wave

 = velocity of the observer (you)

 = velocity of the source

Do ***NOT*** try and memorize this equation! Use reason to determine the effect on the frequency of the original wave.

* If you (the receiver) are moving toward the sound, this makes the pulses arrive sooner, which makes the frequency higher.
* So if you are moving ***toward*** the sound, ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_***your velocity. If you are moving ***away***, ***\_\_\_\_\_\_\_\_\_\_\_\_\_*** your velocity.
* If the source is moving toward you (the receiver), this makes the frequency higher, which means the denominator needs to be smaller.
* If the source is moving ***toward*** you, ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_*** its velocity. If the source is moving ***away*** from you, ***\_\_\_\_\_\_\_\_\_\_*** its velocity.

A flying bat emits squeaks at a frequency of 85 kHz. If a stationary observer picks up the frequency of the squeaks as 80 kHz, is the bat moving towards or away from the listener? *Determine the speed at which the bat is flying.*

The horn on a fire truck sounds at a pitch of 350 Hz. What is the perceived frequency when the fire truck is moving toward you at ? *Assume the speed of sound in air is .*

Unit 7: Waves **2 – Interference (Standing Waves and Resonance Pipes)**

|  |  |  |  |
| --- | --- | --- | --- |
| Type: | Pattern: | Type: | Pattern: |
|  | |  | |
| Type: | Pattern: | Type: | Pattern: |
|  | |  | |
| Type: | Pattern: | Type: | Pattern: |
|  | |  | |

Two waves with the same frequency and opposite phase.

**Destructive Interference:**

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

When two waves travel in the same medium they affect the medium independently. To determine their **overall** effect we use the principle of superposition.

**Principle of Superposition:**

The total amplitude of the waves is equal to…

**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…
* If the waves are sent at just the right frequency we will create a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Standing waves are caused by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Areas of complete destructive interference have \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and are called \_\_\_\_\_\_\_\_\_\_
* Areas of complete constructive interference have \_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and are called \_\_\_\_\_\_\_\_\_\_

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

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Sample Problems: Interference of Waves**  Draw the interference pattern for the combinations of waves shown below. Show your calculations for the amplitude at each marked () location . | | |
| **1.** | | | |
| 1st dot: Amplitude = 0 + 0 = 0  2nd dot: Amplitude = 4 + \_\_\_\_ = 6  3rd dot: Amplitude = \_\_\_\_ + \_\_\_\_ = 0  4th dot: Amplitude = -4 + \_\_\_\_ = \_\_\_\_\_  5th dot: Amplitude = \_\_\_\_ + \_\_\_\_ = \_\_\_\_\_ | | *Check that the amplitudes drawn in the interference pattern match the values that you calculated for each ‘dot’.* |  |
| **2.** | | | |
| 1st dot: Amplitude = 0 + 2 = \_\_\_\_  2nd dot: Amplitude = \_\_\_\_ + -2 = \_\_\_\_\_  3rd dot: Amplitude = \_\_\_\_ + \_\_\_\_ = \_\_\_\_\_  4th dot: Amplitude = \_\_\_\_ + \_\_\_\_ = \_\_\_\_\_ | | *Draw the interference pattern...* |  |



In certain waves interference occurs in such a way that specific points along the medium appear to be standing still…

This is known as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_.

The observed wave pattern is characterized by points that appear to be ***standing still***.

These vibrations contain both \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (N)

and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (A).

Patterns are only created within the medium at specific ***frequencies/vibration***.

These frequencies are known as **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

Closed-Closed Pipes

* Closed-Closed resonance pipes are defined by both ends being fixed and are therefore \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

|  |  |  |
| --- | --- | --- |
|  | **λ =** | **Harmonic** |
|  |  |
|  | **λ =** | **Harmonic** |
|  |  |
|  | **λ =** | **Harmonic** |
|  |  |

Open-Open Pipes

* Open-Open resonance pipes are defined by two ends that can move and are therefore \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

|  |  |  |
| --- | --- | --- |
|  | **λ =** | **Harmonic** |
|  |  |
|  | **λ =** | **Harmonic** |
|  |  |
|  | **λ =** | **Harmonic** |
|  |  |

Open-Closed Pipes

* Open-Closed resonance pipes are defined by one end being fixed and the other movable.

|  |  |  |
| --- | --- | --- |
|  | **λ =** | **Harmonic** |
|  |  |
|  | **λ =** | **Harmonic** |
|  |  |
|  | **λ =** | **Harmonic** |
|  |  |