Name: _____

Period: _____

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Supplement: Harmonic Motion Equations

Period vs. Frequency

The ***period*** is how long it takes to complete one cycle.
The ***frequency*** is how many cycles occur per second.
Hertz (***Hz***) means cycles per second.

Period (in *secs*) → $T = \frac{1}{f}$ OR $f = \frac{1}{T}$ ← Period (in *secs*)

Frequency (in *hertz*)

If you know frequency you can find period.

Ex: A wave has a frequency of 10 Hz. Find its period.	
f = 10 Hz T = ?	T = 1/f T = 1/10 Hz **T = 0.1 sec**

If you know period you can find frequency.

Ex: A pendulum has a period of 0.5 seconds. Find its frequency.	
T = 0.5 sec f = ?	f = 1/T f = 1/0.5 sec **f = 2 Hz**

Harmonics

f_f – is the frequency of the ***fundamental*** (in ***Hz***).
f_{Hx} – is the frequency of the ***harmonic*** (in ***Hz***).
X – is the number of the harmonic (if H_3, X = 3)

Frequency of Harmonics

Frequency of harmonic x (in *Hz*) → $f_{Hx} = f_f(X)$ ← # of the Harmonic

Frequency of the fundamental (in *Hz*)

If you are given the fundamental you can find the frequencies of any of the harmonics.

Ex. Find the frequency of the fourth harmonic (H_4) of a 6 Hz fundamental.	
f_f = 6 Hz X = 4 (fourth) f_{H4} = ?	$f_{Hx} = f_f(X)$ f_{H4}= (6 Hz) x (4) f_{H4} = 24 Hz

If you are given the harmonic frequency and what harmonic it is you can find the frequency of the fundamental.

Ex. If the eighth harmonic has a frequency of 80 Hz, find the fundamental frequency.	
f_{H8} = 80 Hz X = 8 f_f = ?	$f_{Hx} = f_f(X)$ $f_f = f_{Hx}/X$ = 80 Hz/8 f_f = 10 Hz

Speed of a Wave

λ – is lambda (Greek); used for wavelength: the length of one wave cycle.
v – is velocity, but here we use it for speed, too.

The Speed (velocity) of a Wave

velocity (*m/sec*) → $v = f\lambda$ ← wavelength (*m*)

frequency (*Hz*)

You can find speed from frequency and wavelength.

Ex. Find the speed of a 60 Hz wave if one cycle is 4 meters long.	
f = 60 Hz λ = 4 m v = ?	v = f λ v = (60 Hz) x (4 m) v = 240 m/s

You can find either wavelength or frequency if you know the wave's speed.

Ex. What wavelength wave has a 200 m/s velocity and 50 Hz frequency?	
f = 50 Hz v = 200 m/s λ = ?	v = f λ SO λ = v/f λ = (200 m/s) ÷ (50 Hz) λ = 4 m

Speed of Sound (v_s)

The ***Speed of Sound in air*** is approximately ***340 m/sec.*** Use this number anytime a problem refers to a sound wave, music, a noise, or someone hearing something.

The Speed of a Sound Wave

$$340 \text{ m/sec} = f\lambda$$

Speed

$$S = \frac{D}{T}$$

Because you know the speed of sound, if you know λ you can *f* and vice versa.

Ex. Find the wavelength of a 100 Hz sound.	
v_s = 340 m/s f = 100 Hz λ = ?	v = f λ so λ = v/f λ = (340 m/s) ÷ (100 Hz) λ = 3.4 m

If you know how long it takes a sound to reach you, you can find how far away the sound source is.

Ex. If you hear a sound 2 seconds after you see the motion, how far away is it?	
v_s = 340 m/s T = 2 sec D = ?	v_s = D/T SO D = v_sT D = (340 m/s) X (2 sec) D = 680 m

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Decibels (Loudness)

A + 10 dB change we hear as twice as loud.	***A - 10 dB change we hear as half as loud.***

Ex. How much louder is a 50 dB noise than a 40 dB noise?	*Ex. How much softer is a 25 dB noise than a 35 dB noise?*
50 dB – 40 dB = +50 dB 50 dB is twice as loud as 40	25 dB – 35 dB = -10 dB 25 dB is half as loud as 35 dB.

Amplitude

2 ways: 1) **Amplitude = ½(high – low)** OR 2) **1/2 (peak to peak)**. (Distance from trough to crest divided by 2)

Ex. Crest is at 3 cm; Trough is at –5 cm. Find amplitude.

Way 1) A = 1/2 (3cm – (-5cm)) =
1/2 (3cm + 5cm) = 1/2(8) = 4 cm.

Way 2) From –5 to 0 = 5cm 5 + 3 = 8.
A = 1/2(8) = 4 cm

What is the period of a 4 Hz wave?

What is the speed of a 10 Hz wave that's wavelength is 25 m?

What is the frequency of a wave with a 2 second period?

How much louder is a 45 dB sound than a 35 dB sound?

If a noise drops from 80 dB to 70 dB, how do we hear the change?

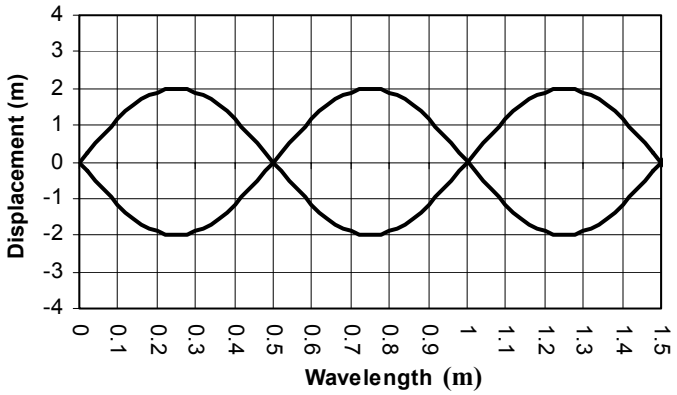
If a standing wave's fundamental is 12 Hz what is the frequency of harmonic 4? (And how many antinodes will harmonic 4 have?)

You hear a hammer 5 seconds after you see it move. How far away is the hammer?

A sound wave has a 10 m wavelength. Find its frequency.

If a noise has a frequency of 17 Hz, find its wavelength.

Standing wave (Harmonic)



Use the above graph to answer the following questions:

What harmonic is it? _____

Mark the nodes and antinodes: _____

If it's frequency is 60 Hz find its period: _____

Could a human hear this frequency? _____

Find the fundamental frequency:

_____

Find the 4th harmonic frequency:

_____

What is the amplitude of the wave? _____

What is the wavelength of the wave? _____

The total length of the standing wave is how many wavelengths?

_____