Name: _____

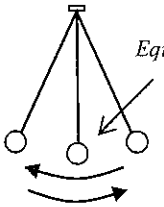
Period: _____

Unit 10:1

Harmonic Motion

Harmonic Motion is motion that repeats itself, oscillating back and forth. Eventually it will lose energy (called dampening) and come to rest in the middle, known as its **equilibrium position.**

A pendulum



To be harmonic motion there must be a **restoring force** that tries to return an object to its equilibrium position. When a pendulum is disturbed (moved), gravity pulls down to restore the pendulum back to the center. Because of momentum, it goes past the center to the other side and back again.

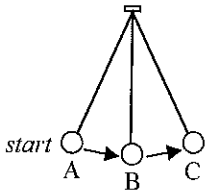
A bird flying ***is not*** *harmonic motion: one force pulls up and a different force pulls down. Also, each force pulls from the ends not the middle.*

Harmonic Motion Basics

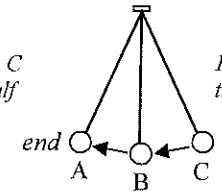
Cycle: the repeated part of the motion; must include all of the steps of the motion.

Period (T in sec): length of time for one cycle; how long it takes for one repetition. A slower object has a bigger (longer) period .

Frequency (f in Hz): number of cycles per second. Motion that repeats more often is more frequent and has a higher frequency.



From A to C is only half a cycle.



From C to A is the second half of the cycle.

The period (T) is the time from A back to A. T = 2 sec.

Only half of the cycle occurs in the first second, so the frequency is ½ cycle per second. f = 0.5 Hz.

Period and Frequency are inversely related.

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

Frequency (in *hertz*)

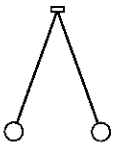
As period increases, the frequency decreases.
As period decreases, the frequency increases.

Ex: A pendulum has a frequency of 4 Hz. Find its period.	
f = 4 Hz T = ____	T = 1/f T = 1/4 T = 0.25 sec

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

Amplitude (A in m, cm, or degrees): maximum distance or angle from the equilibrium (center) position. Wider swing = more energy = more amplitude.

Amplitude = ½(distance side-to-side)



Amplitude = More energy

Amplitude = Less energy

Amplitude never affects period or frequency! A pendulum with more amplitude moves fast, but travels a long distance. A pendulum with less amplitude moves slow, but only travels a small distance. Either way, the period is the same.

Harmonic Motion Graphs

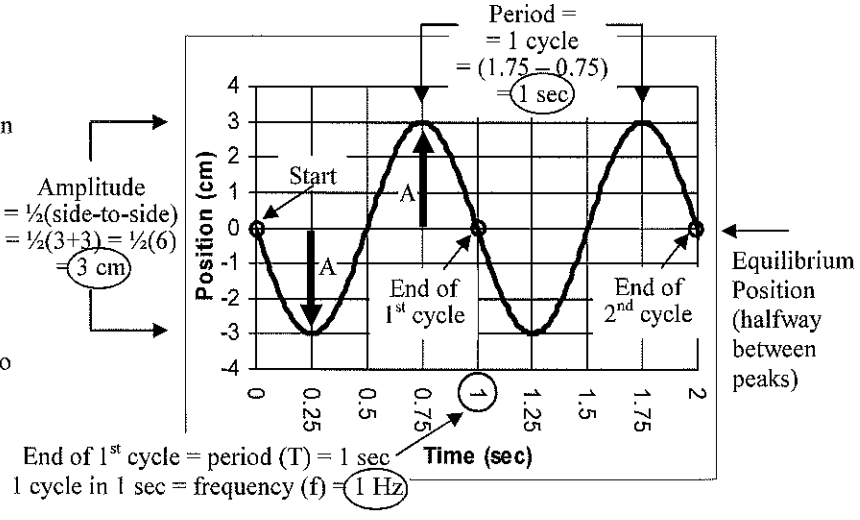
Imagine a pen attached to the bottom of a pendulum. If a piece of paper is moved beneath the pendulum as it swings, a harmonic motion graph is drawn.

Cycle—from any point on the line to that same point going the same way. This graph shows 2 complete cycles.

Period—measure the time for one cycle between any two identical points on the graph (top-to-top, bottom-to-bottom, etc.).

Frequency—count the number of cycles in 1 second OR find the period and use f = 1/T.

Amplitude—measure the total distance from side-to-side (or top-to-bottom) and divide by two OR measure the distance from the equilibrium position (halfway between the peaks) to one of the peaks.



Name: _____ Harmonic Motion Unit 10:1

Period: _____

Harmonic Motion: Yes or No?

Pendulum: _____ A bouncing ball: _____

Ocean waves: _____ A ruler pulled from one side and released: _____

A child on a swing: _____ A person jumping up and down: _____

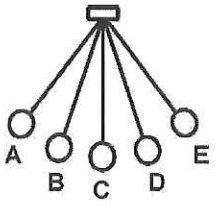
Jumping Jacks: _____

Bouncing spring: _____ A spinning ball: _____

1. Period	A. The number of cycles per second.
2. Equilibrium position	B. A unit of one cycle per second.
3. Amplitude	C. The size or strength of a cycle.
4. Damping	D. Time it takes to complete one cycle.
5. Frequency	E. A part of motion that repeats over and over with a set series of events.
6. Cycle	F. Halfway between the two sides and where the motion comes to rest.
7. Hertz	G. The motion dying out over time.

Period, Frequency, or Amplitude?

____ Doesn't change period.
____ More of this means more energy.
____ Increases as a pendulum swings back and forth faster.
____ Measured in cycles per second.
____ Measured in meters or centimeters.
____ This decreases with a smaller swing.
____ If the frequency increases, this decreases.
____ Measured in Hertz.
____ Measured in seconds.
____ If it swings back and forth slower, this decreases.
____ As it dampens, this decreases.



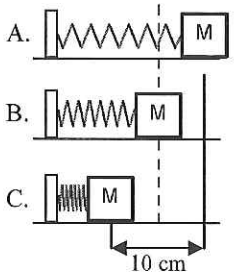
Where is the equilibrium position for this pendulum?

If the pendulum starts at C going to the right, where does 1 cycle end?

From letter ____ to letter ____ would be the amplitude.

If the pendulum starts at A, how many times does it pass point C in 1 cycle?

A moving spring



Where is its equilibrium position?

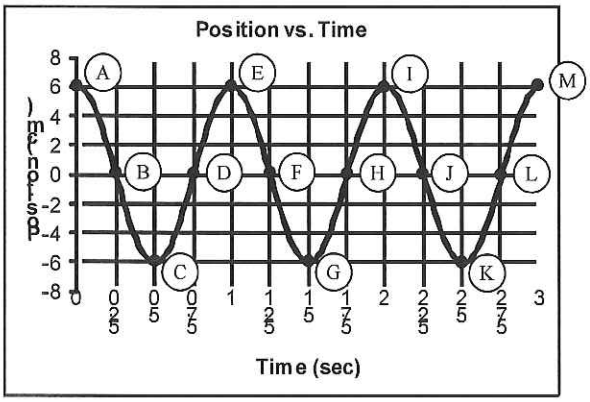
If the spring starts at position A, how much of a cycle does it complete from A to C?

If the spring moves 10 cm from C to A (side to side), how big is it's amplitude?

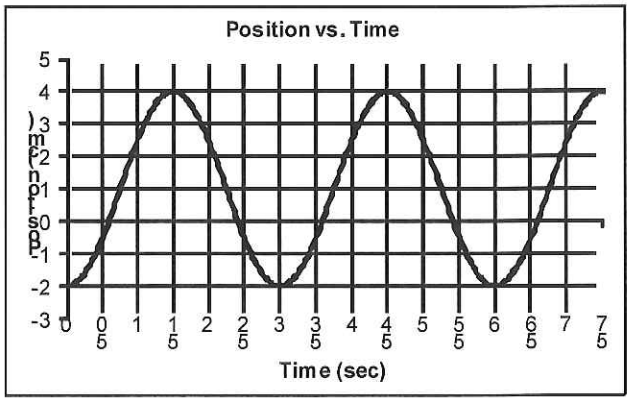
An spring has a period of 4 seconds. What is its frequency?

A pendulum has a frequency of 3 Hz. What is its period?

A pendulum takes 10 seconds to complete 2 cycles.
A) What is its period?
B) What is its frequency?



1 cycle after A is ____; 2 cycles after D is ____.
1/2 cycle after G is ____; 1/4 cycle before M is ____.
# of complete cycles shown is ____.
Period (T) = Frequency (f) =
Equilibrium position = Amplitude (A) =



Mark 1 cycle of the harmonic motion.
Starting at 1.5 secs, when does the 2nd cycle end:
Number of cycles shown is ____.
Period (T) = Frequency (f) =
Equilibrium position = Amplitude (A) =

Name: _____ **Harmonic Motion** Unit 10:1

Period: _____

Which of these is Harmonic Motion?

Pendulum: Y

Ocean waves: Y

A child on a swing: Y

Jumping Jacks: N

Bouncing spring: Y

A bouncing ball: N

A ruler pulled from one side and released: Y

A person jumping up and down: N

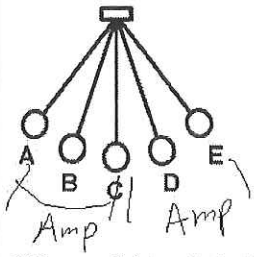
A spinning ball: N

1. Period D
2. Equilibrium position F
3. Amplitude C
4. Damping G
5. Frequency A
6. Cycle E
7. Hertz B

A. The number of cycles per second.
B. A unit of one cycle per second.
C. The size or strength of a cycle.
D. Time it takes to complete one cycle.
E. A part of motion that repeats over and over with a set series of events.
F. Halfway between the two sides and where the motion comes to rest.
G. The motion dying out over time.

☆ *Period, Frequency, or Amplitude?*

A Doesn't change period.
A More of this means more energy.
F Increases as a pendulum swings back and forth faster.
F Measured in cycles per second.
A Measured in meters or centimeters.
A This decreases with a smaller swing.
T If the frequency increases, this decreases.
F Measured in Hertz.
T Measured in seconds.
T If it swings back and forth slower, this decreases.
A As it dampens, this decreases.



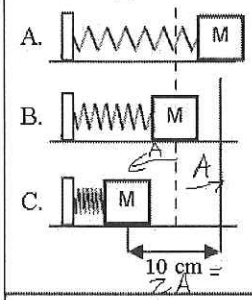
Where is the equilibrium position for this pendulum? C

If the pendulum starts at C going to the right, where does 1 cycle end? C going right

From letter A to letter C would be the amplitude. OR C to E

If the pendulum starts at A, how many times does it pass point C in 1 cycle? two times

A moving spring



Where is its equilibrium position? at B

If the spring starts at position A, how much of a cycle does it complete from A to C? half cycle

If the spring moves 10 cm from C to A (side to side), how big is it's amplitude? 5 cm

An spring has a period of 4 seconds. What is its frequency?

$T = 4\,sec$ $f = \frac{1}{T} = \frac{1}{4} = .25\,Hz$

$f =$ ____

A pendulum has a frequency of 3 Hz. What is its period?

$f = 3\,Hz$ $T = \frac{1}{f} = \frac{1}{3} = .33\,sec$

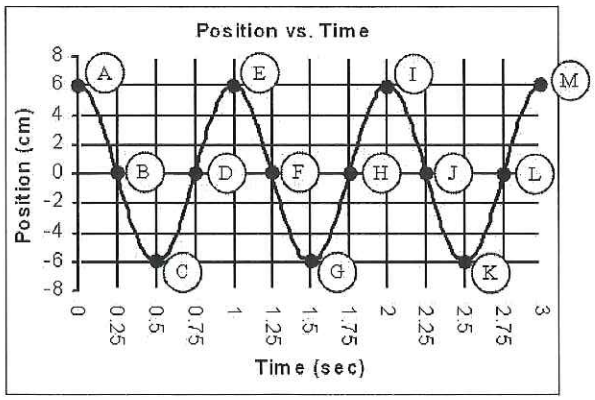
$T =$ ____

A pendulum takes 10 seconds to complete 2 cycles.

A) What is its period? 5 sec

B) What is its frequency?

$f = \frac{1}{5} = .2\,Hz$



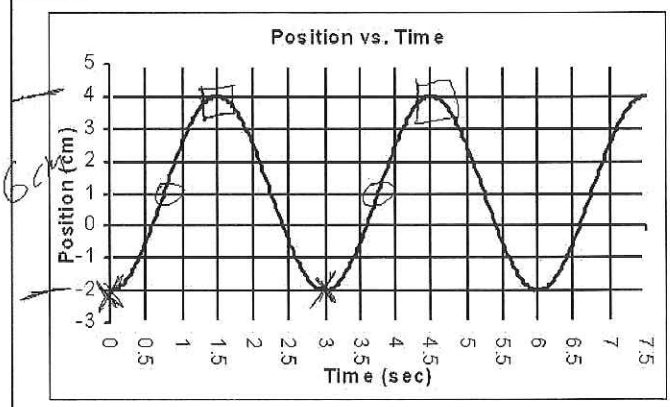
1 cycle after A is E; 2 cycles after D is L.

1/2 cycle after G is I; 1/4 cycle before M is L.

# of complete cycles shown is 3.

Period (T) = 1 sec Frequency (f) = $\frac{1}{T} = \frac{1}{1} = 1\,Hz$

Equilibrium position = 0 cm Amplitude (A) = 6 cm



Mark 1 cycle of the harmonic motion.

Starting at 1.5 secs, when does the 2nd cycle end: 7.5 sec

Number of cycles shown is 2.5 cycles

Period (T) = 3 sec Frequency (f) = $\frac{1}{3} = .33\,Hz$

Equilibrium position = 1 cm Amplitude (A) = 3 cm

Name: _____

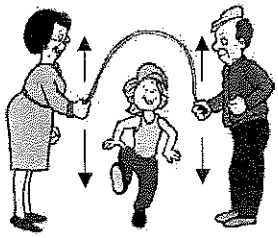
Period: _____

Ch 12:1

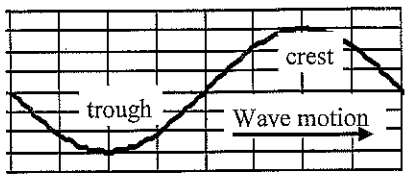
Standing Waves

We know that waves move. Yet waves can be trapped between ***boundaries***. These are known as ***standing waves***.

A jump rope is a good example of a standing wave.



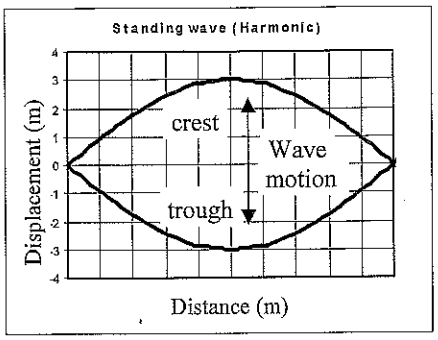
To keep a standing wave going it needs to have a *driven end:* an end that gives energy to the wave. Jump ropes have *two* driven ends.



A moving wave.

In a *moving* wave, the wave moves away from what drives it. Waves that move away from a rock in a pond are driven by the force of the rock pushing through the water.

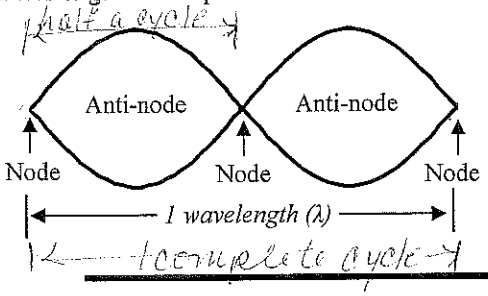
Standing waves are TRAPPED between boundaries, so we show both the crest and the trough in the same place at the same time. In reality, though, it alternates: going up and down, just like a jump rope.



A graph of the fundamental wave for this distance.

The largest wave that can be produced in a certain distance is called the ***fundamental***. It is one-half of one wavelength long.

The places of no amplitude are called ***nodes***. The places of greatest amplitude are called ***anti-nodes***.



In a standing wave, each anti-node is one-half of a wavelength.

1 Anti-node = (1/2)λ

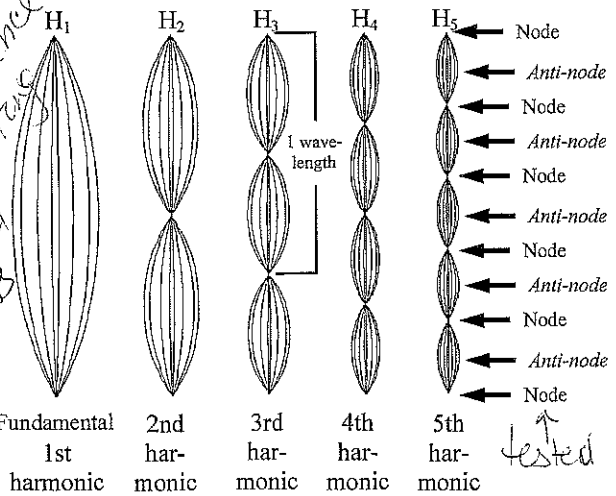
2 Anti-nodes = λ

Harmonics

Harmonics are waves that are whole number multiples of the fundamental. ***Harmonics*** have nodes at the boundaries. Harmonics sound louder, keep their energy longer, and take less energy to produce.

harmonics is a type of resonance with interesting musical students

First 5 Harmonics of a Vibrating String



not tested

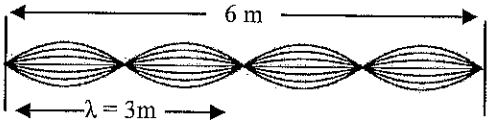
tested

Examples of Fundamentals and their Harmonics				
H_1 (f_f)	***H_2***	***H_3***	***H_4***	***H_5***
1 Hz	2 Hz	3 Hz	4 Hz	5 Hz
2 Hz	4 Hz	6 Hz	8 Hz	10 Hz
5 Hz	10 Hz	15 Hz	20 Hz	25 Hz
10 Hz	20 Hz	30 Hz	40 Hz	50 Hz

Speed of a Standing Wave

★ important

To find the speed of a fixed string you would need to know the frequency of any harmonic and that harmonic's wavelength.



Remember that λ (wavelength) = 2 antinodes!	λ = 3m	v = fλ
	f = 21 Hz	v = 21(3)
	v = _____	v = 63 m/s

f = frequency (Hz) = (cycles / s)

λ = wavelength (m)

V = f λ inverse

T = period (s)

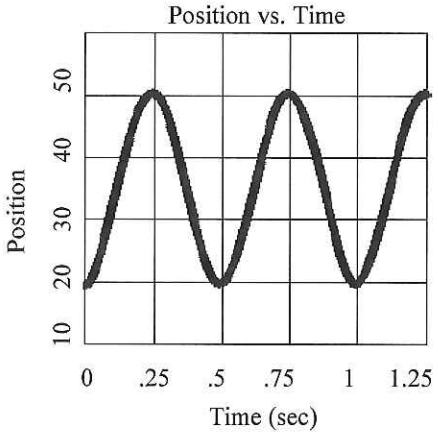
f = 1/T 1 = fT inverse

Name: _____

Period: _____

Standing Waves

1. Boundary	A. The part that is moved to give energy.
2. Standing wave	B. Where wave's amplitude is greatest.
3. Harmonic	C. Where the wave has no motion.
4. Fundamental	D. A wave that is a multiple of another wave.
5. Driven end	E. A wave that is trapped within boundaries.
6. Node	F. The first harmonic of a standing wave, equal to 1/2 its wavelength.
7. Anti-node	G. A place that limits a wave's motion.



# of cycles: _____

Period: _____

Frequency: _____

Amplitude: _____

1. f = _____	8 m/s
2. v = _____	8 sec
3. λ = _____	8 Hz
4. T = _____	8 m

If a wave's frequency is 25 Hz, what is its period?

A string has a fundamental of 15 Hz, find the frequency of harmonic 3 (H_3).

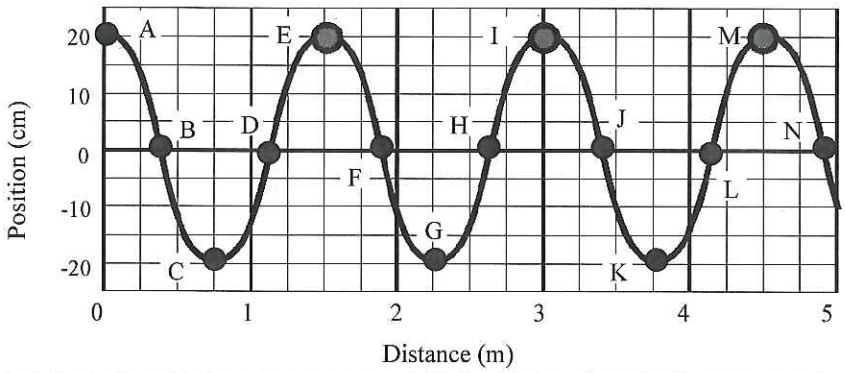
If a wave's period is 0.1 sec, find its frequency.

If 20 Hz is the fundamental, find H_6.

If a wave has a frequency of 50 Hz and a wavelength of 2 meters. Find its speed.

If 35 Hz is H_7, what is the fundamental frequency?

A wave's velocity is 20 m/sec with a wavelength of 40 m. What is it's frequency?



One cycle: A to ____; C to ____; F to ____.

Half cycle: H to ____; J to ____; B to ____.

Two cycles: B to ____; D to ____; E to ____.

Total cycles: _____

Wavelength: _____

Amplitude: _____

The following table shows the frequencies of the first 5 harmonics of different strings. Fill in the blank spaces.

1	2	3	4	5
4 Hz				
6 Hz				
	4 Hz			
		36 Hz		
			44 Hz	

A fellow student shows you the frequencies of four harmonics of a string. Which one would you question and why?
Frequencies: 12 Hz; 24 Hz; 29 Hz; 48 Hz

Find its period: _____

Mark the nodes and anti-nodes.

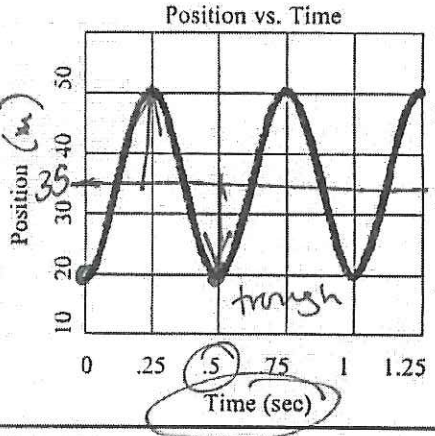
40 Hz

Name: _____

Period: _____

Standing Waves

1. Boundary	A. The part that is moved to give energy.
2. Standing wave	B. Where wave's amplitude is greatest.
3. Harmonic	C. Where the wave has no motion.
4. Fundamental	D. A wave that is a multiple of another wave.
5. Driven end	E. A wave that is trapped within boundaries.
6. Node	F. The first harmonic of a standing wave, equal to 1/2 its wavelength.
7. Anti-node	G. A place that limits a wave's motion.



# of cycles: 2½

Period: 0.5s

Frequency: 2Hz $= \frac{1}{T}$

Amplitude: 15m

1. f = _____	8 m/s
2. v = _____	8 sec
3. λ = _____	8 Hz
4. T = _____	8 m

If a wave's frequency is 25 Hz, what is its period?

0.04 s $\frac{1}{f}$

If a wave's period is 0.1 sec, find its frequency.

10Hz $\frac{1}{T}$

If a wave has a frequency of 50 Hz and a wavelength of 2 meters. Find its speed.

$V = \lambda f$ 100 m/s

A string has a fundamental of 15 Hz, find the frequency of harmonic 3 (H_3).

45Hz 15 x 3 = 45Hz

If 20 Hz is the fundamental, find H_6.

120Hz 20 x 6 = 120Hz

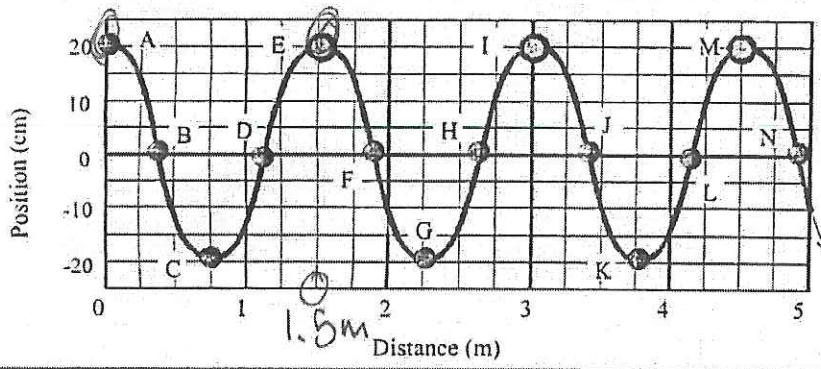
If 35 Hz is H_7, what is the fundamental frequency?

5Hz 35Hz/7 = 5Hz

A wave's velocity is 20 m/sec with a wavelength of 40 m. What is it's frequency?

$V = \lambda f$

$20 = 40f$ $f = 0.5$Hz



One cycle: A to E; C to G; F to J.

Half cycle: H to J; J to L; B to D.

Two cycles: B to J; D to N; E to M.

Total cycles: 3 1/3

Wavelength: 1.5m

Amplitude: 20cm

The following table shows the frequencies of the first 5 harmonics of different strings. Fill in the blank spaces.

1	2	3	4	5
4 Hz	8			
6 Hz	12			
2	4 Hz			
12	24	36 Hz		
11	22		44 Hz	

A fellow student shows you the frequencies of four harmonics of a string. Which one would you question and why?

Frequencies: 12 Hz; 24 Hz; 29 Hz; 48 Hz

Resonance

Find its period: $T = \frac{1}{40}s = .025$ s

What harmonic is this? 2

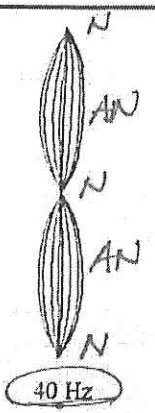
Mark the nodes and anti-nodes.

Find the fundamental frequency:

$\frac{40Hz}{2} = 20Hz = f_f$

3rd harmonic frequency: 20Hz x 3

60Hz



Name: _____

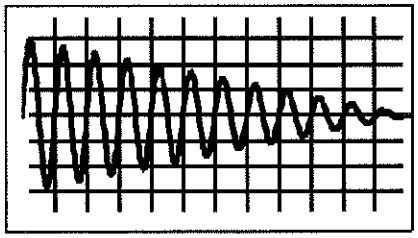
Period: _____

Unit 10:4

Wave Actions

Damping

Harmonic motion eventually stops. A pendulum will stop swinging; a wave will eventually weaken and stop. Friction or the restoring force causes the motion to lose its energy and to die out. This gradual reduction of amplitude we call ***damping***.



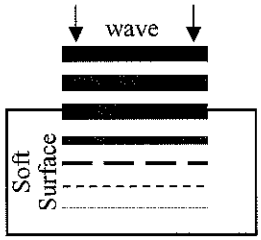
This graph shows the damping of harmonic motion over time until it stops at its equilibrium position.

Boundary Reactions

There are four ways a wave can react depending on the boundary it encounters: ***Absorption; Reflection; Refraction; Diffraction.***

Soft Boundaries Absorb

Absorption—a wave's energy dies out in a soft material (damping). *Example: Yelling into a pillow. The soft pillow* ***absorbs*** *(dampens) the sound.*



Absorption

Corners Diffract

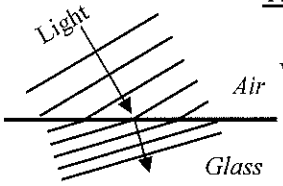
Diffraction—a wave drags against a corner, causing that part of the wave to turn. This is how we can hear around corners and how light can be seen around corners. *Example: talking to someone around a corner.*

Diffraction

Reflection

Hard Boundaries Reflect

Reflection—a wave bounces off when it hits a hard boundary. *Example: yelling against a wall, the sound wave* ***reflects*** *back (called an echo).*



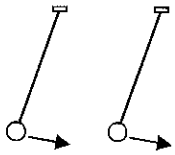
Refraction

Transparent Boundaries Refract

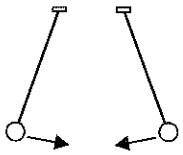
Refraction— a wave bends when it crosses a boundary into a different medium and changes speed. *Example: light bends as it passes from air into the lenses of eyeglasses.*

Phase

Phase—a particular part of a cycle.

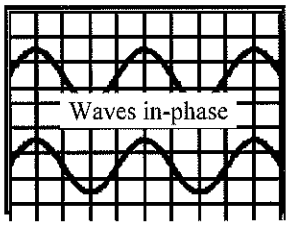


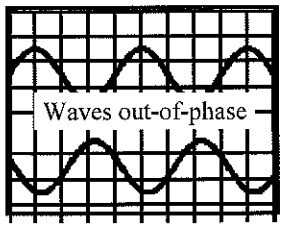
In-phase means they are at the same point in their cycles.



Out-of-phase means they are at *different points* in their cycles.

In-phase *out-of-phase*

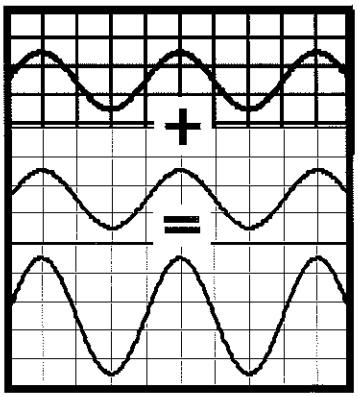




Interference

When two waves interact they ***interfere*** *with each other.*

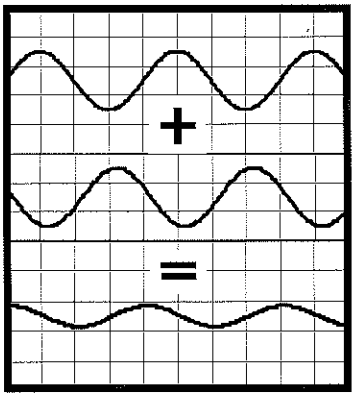
Constructive Interference—when the energy of **two waves** add together. This is like pushing on a person on a swing when they are moving away from you: you give them more energy and more amplitude.



Two waves of small amplitude that are ***in-phase constructively interfere,*** combining into a wave of greater amplitude.

Two singers on the same note cause a louder sound—constructive interference.

Destructive Interference—when the energy of **two waves** subtract from each other, causing cancellation. Pushing on a person on a swing as they are coming toward you (at the wrong time) causes the amplitude to be smaller.



Two waves that are ***out-of-phase destructively interfere,*** combining into a wave of smaller amplitude. Waves that completely **cancel** each other it is known as **complete destructive interference.**

Modern headphones (and cars) use *noise-canceling technology* that transmits out-of-phase waves toward noise, canceling it out.

Name: _____ Wave Actions Unit 10:4

Period: _____

1. Phase	A. When two waves increase amplitude.
2. In-phase	B. A single part of a cycle.
3. Out-of-phase	C. When two waves decrease amplitude.
4. Constructive interference	D. When two waves are at different parts of their cycles.
5. Destructive interference	E. When two waves are at the same part of their cycles.

1. Absorption	A. When a wave bends at a corner.
2. Refraction	B. The process of harmonic motion losing amplitude over time.
3. Diffraction	C. When a wave is dampened inside a soft boundary.
4. Reflection	D. A wave bouncing off of a hard boundary.
5. Damping	E. A wave bending inside transparent objects.

Absorption, Reflection, Refraction, or Diffraction?

If a wave hits a hard wall, it bounces off by: _____

If a wave hits a soft boundary, it dies by: _____

Waves bending due to different speed mediums: _____

A wave bends around a corner by: _____

A wave bends as it passes thru a boundary by: _____

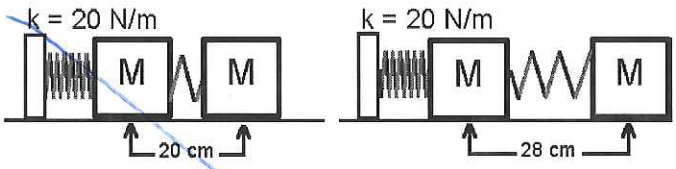
Tile or marble makes for a loud room by: _____

Eyeglasses magnify objects by: _____

How bats see at night with sound (echolocation): _____

Carpet can keep a room quiet by: _____

Light comes back from a mirror by: _____



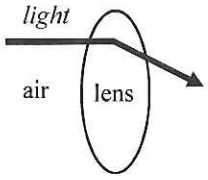
The above is the same spring, but at different times.

Amplitude of the left spring = _____. Right spring = _____

Which picture is the before picture?

Why?

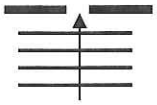
What is this bending called?



The light ray bends because the lens has a different w_____ s_____ than air.

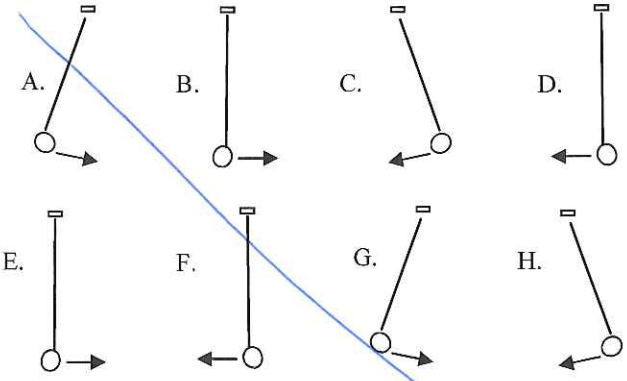
Draw what will happen to the waves as they pass the two corners.

Combining the above, draw what will happen to the wave as it goes through a hole.



What do we call this?

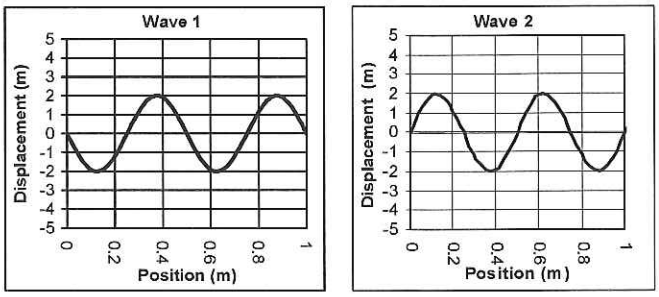
The following show pendulums in different phases of a cycle.



Which letter is in-phase with G? ____ With D? ____

Which letter is 180° out-of-phase of E? ____ With H? ____

Which letter is 90° out-of phase of F? ____ with G? ____



What is the amplitude of wave 1? Wave 2?

Are they in-phase?

What will happen if the waves combine?

What will be the amplitude of the combined wave?

Name: _____ **Wave Actions** Unit 10:4

Period: _____

1. Phase B	A. When two waves increase amplitude.
2. In-phase E	B. A single part of a cycle.
3. Out-of-phase D	C. When two waves decrease amplitude.
4. Constructive A interference	D. When two waves are at different parts of their cycles.
5. Destructive C interference	E. When two waves are at the same part of their cycles.

1. Absorption C	A. When a wave bends at a corner.
2. Refraction E	B. The process of harmonic motion losing amplitude over time.
3. Diffraction A	C. When a wave is dampened inside a soft boundary.
4. Reflection D	D. A wave bouncing off of a hard boundary.
5. Damping B	E. A wave bending inside transparent objects.

Absorption, Reflection, Refraction, or Diffraction?

If a wave hits a hard wall, it bounces off by: reflection

If a wave hits a soft boundary, it dies by: absorption

Waves bending due to different speed mediums: refraction

A wave bends around a corner by: diffraction

A wave bends as it passes thru a boundary by: refraction

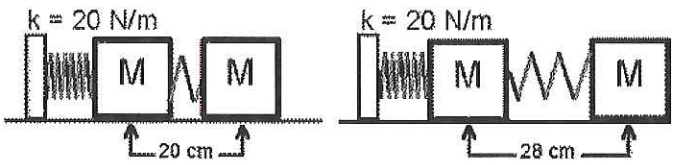
Tile or marble makes for a loud room by: reflection

Eyeglasses magnify objects by: refraction

How bats see at night with sound (echolocation): reflection

Carpet can keep a room quiet by: absorption

Light comes back from a mirror by: reflection



The above is the same spring, but at different times.

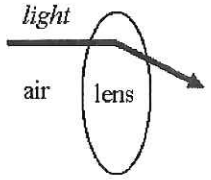
Amplitude of the left spring = 10 cm. Right spring = 14 cm

Which picture is the before picture? Right picture

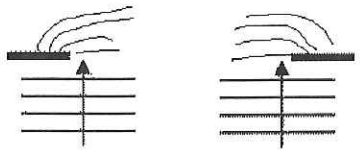
Why? It will dampen over time, so ampl. is smaller afterwards.

What is this bending called? refraction

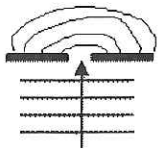
The light ray bends because the lens has a different w ave s peed than air.



Draw what will happen to the waves as they pass the two corners.

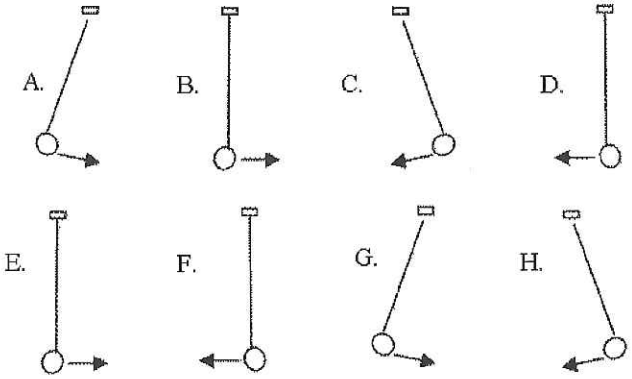


Combining the above, draw what will happen to the wave as it goes through a hole.



What do we call this? Diffraction

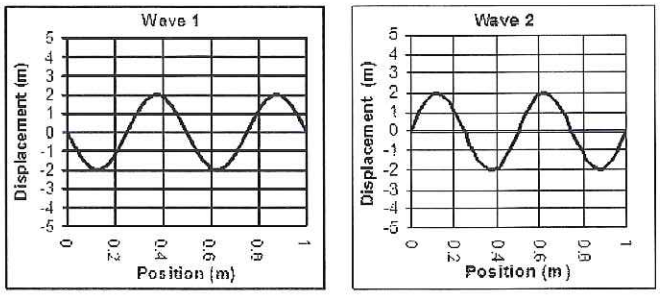
The following show pendulums in different phases of a cycle.



Which letter is in-phase with G? A With D? F

Which letter is 180° out-of-phase of E? B (F) With H? A (G)

Which letter is 90° out-of phase of F? G (H, C, A) with G? F, D, E



What is the amplitude of wave 1? 2m Wave 2? 2cm

Are they in-phase? No

What will happen if the waves combine? They will cancel each other – destructive interference.

What will be the amplitude of the combined wave? 0 m

Name: _____

Period: _____

Unit 10:5

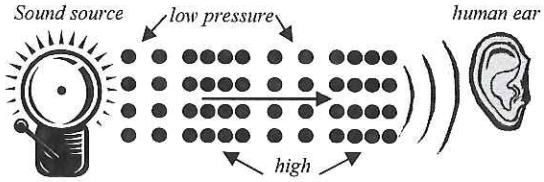
Sound

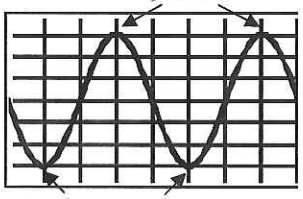
What is Sound?

Sound is the movement of compression waves (longitudinal waves) hitting our ears. These compression waves are alternating high and low pressure areas. The air molecules vibrate back and forth, but don't travel.

Speakers imitate sounds by pushing air and causing vibrations.

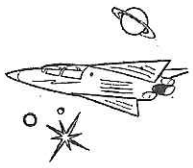
Sound Wave are Pressure Waves



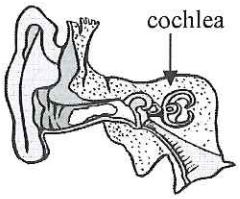


On graphs, we use crests and troughs to show high and low pressure.

As a wave sound needs a *medium* to travel through. Sound cannot travel through the vacuum of space. ***Space is silent*** (no matter what you hear in the movies).



Tiny hairs inside the ***cochlea*** (inner ear) translate air pressure into electrical impulses that can be read by the brain. Very loud sounds bend these hairs, causing deafness.



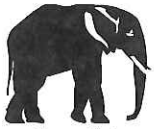
Frequency = Pitch

We hear the frequency of sound as ***pitch***. A higher frequency we hear as a higher pitch. A lower frequency we hear as a lower pitch.

Higher Frequency = Higher Pitch

Frequency (f)	Wavelength (λ)	Source
20 Hz	17 m	rumble of thunder
100 Hz	3.4 m	bass guitar
2,000 Hz	17 cm	fire truck siren
4,000 Hz	7 cm	highest note of piano
10,000 Hz	3.4 cm	whine of a jet turbine

Humans can hear frequencies that are between 20 Hz and 20,000 Hz!



Elephants and submarines use ***infrasonic*** sound (too low to hear) to communicate over long distances. Very low frequencies (very bass) travel very long distances and can penetrate through water (just like thru cars).

Dog whistles use ***ultrasonic*** frequencies (above human hearing [+20,000 Hz]), but perfect for dog ears!

Amplitude = Loudness

We hear pressure (the amplitude) of sound as ***loudness***. It takes more energy to create a louder sound. Too loud of a sound can cause ***deafness***.

Loudness is measured in decibels (dB)

10 dB	Total silence.
30 dB	Total quiet in the woods at night.
60 dB	Normal conversation.
70 dB	Busy traffic in the city.
90 dB	A jackhammer (hearing damage if not protected)
110 dB	Threshold of pain from sound.
200 dB	Human will die from the sound pressure.

A +10 dB change we hear as twice as loud.

A 30 dB sound is twice as loud as a 20 dB sound.

A -10 dB change we hear as half as loud.

A 30 dB sound is half as loud as a 40 dB sound.

Speed of Sound (v_s)

The speed of sound changes. In gases, hotter (faster) gases conduct sound faster. In solids and liquids, generally denser (tighter) materials are faster.

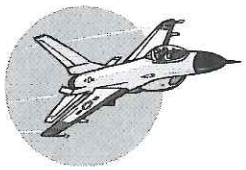
Material	V_s (m/sec)
Air	340
Helium	965
Water	1530
Wood	2000
Gold	3240
Steel	5940

The speed of sound in air is about 340 m/sec.

You can use $v_s = f\lambda$. to find frequency or wavelength.
AND use $S = D/T$ to find distance or time.
In both cases, Vs (S) is a constant for sound: 340 m/sec.

Ex. Find the wavelength of a 200 Hz sound.	
v_s = 340 m/s f = 200 Hz λ = ?	$v = f\lambda$ so $\lambda = v/f$ λ = (340 m/s) ÷ (200 Hz) λ = 1.7 m

Ex. If you hear a sound 3 seconds after you see the motion. How far away is it?	
Vs = 340 m/s T = 3 sec D = ?	$v_s = D/T$ so $D = v_s T$ D = (340 m/s) X (3 sec) D = 1020 m



Motion faster than sound is called ***supersonic***. Supersonic planes give their speed in multiples of ***Mach*** (1 × the speed of sound).

Mach 1 = 340 m/s.
Mach 2 = 680 m/s.

A ***sonic boom*** is caused by an object breaking through the sound barrier. Supersonic planes, bullets, and bullwhips all make sonic booms.

Definitions = important
Rest = extra info to help understanding

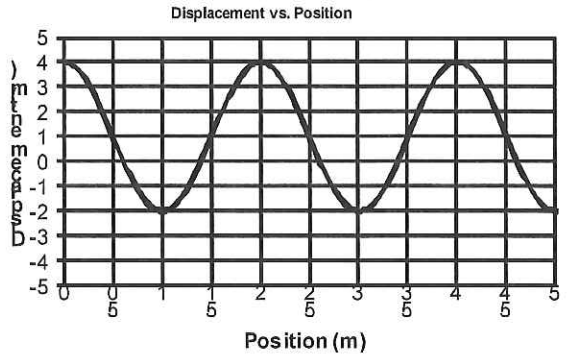
Important calculations

Important #

Name: _____ Sound Unit 10:5

Period: _____

1. Sound	A. Faster than the speed of sound.	1. Pitch	A. Where there is no sound because of its vacuum.
2. Sonic boom	B. A wave caused by alternating high and low pressure.	2. dB	B. How we hear changes of frequency of sound.
3. Supersonic	C. The organ that detects sound waves.	3. Space	C. 340 m/s in air.
4. Ultrasonic	D. A pressure wave caused by an object going faster than sound.	4. Loudness	D. How we measure loudness.
5. Cochlea	E. A sound higher than humans can hear.	5. v_s	E. The amplitude or strength of a sound.



Use the graph to answer these questions: λ = _____

1 cycle is from 1 m to _____; 1/2 cycle is from 0 m to _____.

Amplitude (A) = _____ Total cycles: _____;

It is a sound wave; find frequency:

Is this frequency audible to humans (can we hear it)?

A wave's velocity is 90 m/sec with a frequency of 6 Hz. What is it's wavelength?

A sound wave has a wavelength of 20 m. Find its frequency.

If a sound wave's frequency is 100 Hz. What is its period?

What is the above wave's wavelength?

A railroad crew is repairing a rail. You hear the hammer 0.5 seconds after it is swung. How far away is the crew?

You hear a plane 4 seconds after you see it. Find the distance to the plane.

Why is space silent?

If I increase the energy I give a sound wave what changes:

If a wave's fourth harmonic has a frequency of 40 Hz, what is its natural frequency and what is the frequency of H_6?

If a wave's fundamental is 6 Hz, what harmonic has a frequency of 48 Hz?

If a sound is 40 dB loud. Answer how many dB these would be:

1) A sound twice as loud:

2) A sound half as loud:

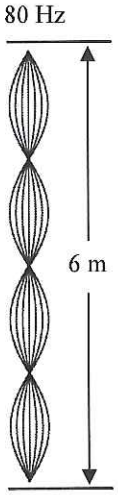
Compared to a 50 dB sound, you would hear a 60 dB as:

Find its period:

Mark the nodes and anti-nodes.
How many wave is it?

What is its wavelength?

Speed of the wave on this string:



Name: _____

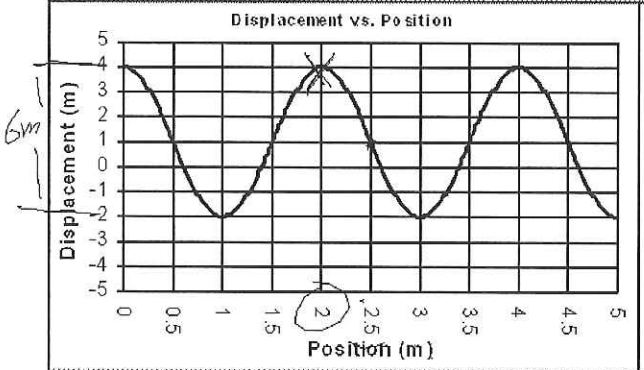
Period: _____

Sound

Ch ~~13.1~~ 10.5

1. Sound B	~~A.~~ Faster than the speed of sound.
2. Sonic boom D	~~B.~~ A wave caused by alternating high and low pressure.
3. Supersonic A	~~C.~~ The organ that detects sound waves.
4. Ultrasonic E	~~D.~~ A pressure wave caused by an object going faster than sound.
5. Cochlea C	~~E.~~ A sound higher than humans can hear.

1. Pitch B	~~A.~~ Where there is no sound because of its vacuum.
2. dB D	~~B.~~ How we hear changes of frequency of sound.
3. Space A	~~C.~~ 340 m/s in air.
4. Loudness E	~~D.~~ How we measure loudness.
5. v_s C	~~E.~~ The amplitude or strength of a sound.



Use the graph to answer these questions: $\lambda =$ 2 m

1 cycle is from 1 m to 3m; 1/2 cycle is from 0 m to 1m.

Amplitude (A) = 3m Total cycles: 2.5;

It is a sound wave; find frequency:

$v = 340\ m/s = f\lambda$ $340 = f(2)$ $f = 170$ Hz

Is this frequency audible to humans (can we hear it)?

yes between 20 – 20,000 Hz

A wave's velocity is 90 m/sec with a frequency of 6 Hz. What is it's wavelength?

$v = f\lambda$ $\lambda = 15$ m

$90 = 6(\lambda)$

A sound wave has a wavelength of 20 m. Find its frequency.

$v = 340 = f\lambda$ $f = 17$ Hz

$340 = f(20)$

If a sound wave's frequency is 100 Hz. What is its period?

$v = 340$ $f = \frac{1}{T}$ $T = \frac{1}{f} = \frac{1}{100} = .01$ sec

What is the above wave's wavelength?

$v = f\lambda$ $\lambda = 3.4$ m

$340 = 100\lambda$

A railroad crew is repairing a rail. You hear the hammer 0.5 seconds after it is swung. How far away is the crew?

$v = 340$ m/s $v = \frac{D}{T}$ $D = vT = 340(.5) = 170$ m

$t = .5$

You hear a plane 4 seconds after you see it. Find the distance to the plane.

$340 = \frac{D}{4}$ $1360\ m = D$

If a sound is 40 dB loud. Answer how many dB these would be:

1) A sound twice as loud: 50 dB
2) A sound half as loud: 30 dB

Compared to a 50 dB sound, you would hear a 60 dB as:

twice as loud

Why is space silent?

no medium (vacuum)

If I increase the energy I give a sound wave what changes:

ampl. = loudness

If a wave's fourth harmonic has a frequency of 40 Hz, what is its natural frequency and what is the frequency of H_6?

$\frac{40}{4} = 10$ Hz H_1 $H_6 = 6(10) = 60$ Hz

If a wave's fundamental is 6 Hz, what harmonic has a frequency of 48 Hz?

$\frac{48}{6} = 8$th harm.

Find its period: $T = 1/80 = .0125$ sec

What harmonic is this? 4

Could a human hear this frequency? yes

Mark the nodes and anti-nodes.

How many wavelengths is it? $2\lambda = 6$m

What is its wavelength? $\lambda = 3$m

Find the fundamental frequency:

$\frac{80}{4} = 20$ Hz

5th harmonic frequency: $20(5) = 100$ Hz

Speed of the wave on this string:

$v = f\lambda = 80(3) = 240$ m/s