Sound and Music   Name ________________________

Part A: Basic Terminology

Sound wave A mechanical longitudinal wave.
Mechanical wave A wave that moves through matter   (different from an electromagnetic wave).
Longitudinal Wave (Level 1 definition) A compression wave. (Level 2 definition) A wave constructed of compression zones and rarefaction zones   (differs from transverse wave) (Level 3 definition) A wave in which the particles move in a direction parallel to the motion of the wave.
Medium The matter a sound wave moves through. A sound wave *must* move through a medium. It *cannot* move through a vacuum.

True or False?

A.1. A sound wave can move through a vacuum.

A.2. A sound wave is transverse.

A.3. A sound wave is longitudinal.

A.4 The medium is what a sound wave moves through.

Wavelength of Sound The distance between two compression zones.
Frequency of Sound The number of compression zones that arrive per minute. Called the *pitch* in musical terms.
Speed of Sound The speed of a sound wave depends on the properties of the air. In air of 0 degrees Celsius and 1 atmosphere of pressure [normal air on a winter day] The speed of sound is 331 m/s.

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Part B: Frequency, Wavelength, and Speed

$$v = f\lambda$$

v	Velocity of wave	Meters/second (m/s)		A constant for all frequencies and wavelengths!
f	Frequency of wave	Hertz (Hz)		This is the *pitch* of your sound wave.
λ	Wavelength	Meters (m)		The symbol is the Greek letter Lambda

Speed of Sound

The speed of a sound wave depends on the properties of the air. [or any medium]
In air of 0 degrees Celsius and 1 atmosphere of pressure [normal air on a winter day, called Standard Temperature and Pressure]
The speed of sound is 331 m/s.

B.1. The air is Standard Temperature and Pressure. What is the speed of sound in this air? If the sound has a frequency of 330 Hertz, what is the wavelength?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

B.2. You are in air of Standard Temperature and Pressure and are making sound waves of 450 Hertz with a guitar. What is the wavelength of these sound waves?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

B.3. You are in Standard Temperature and Pressure and are making sound waves with a wavelength of 0.3 meters. What is the frequency of these sound waves?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

B.4. You are in Standard Temperature and Pressure and are making sound waves with a wavelength of 2 meters. What is the frequency of these sound waves?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

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Frequency and Wavelength

In a sound wave, frequency and wavelength are *inversely proportional*.

As frequency goes UP, wavelength becomes SHORTER. (and vice versa)

As frequency goes DOWN, wavelength becomes LONGER. (and vice versa)

B.5. What happens to wavelength as frequency increases?

B.6. What happens to wavelength as frequency decreases?

B.7. What happens to frequency as wavelength becomes shorter?

B.8. What happens to frequency as wavelength becomes shorter?

B.9. I am playing my guitar, and I start playing the *shorter* strings, which make a shorter wavelength note. What happens to my frequency (the pitch)?

B.10. I am playing a guitar and I start playing the *longer* strings, which make a longer wavelength note. What happens to my frequency?

B.11. I am playing a flute and I hold my fingers so the air has less space to move. This makes a *shorter* wavelength. What happens to my frequency (the pitch)?

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Musical Instrument

A musical instrument works by allowing you to create several different wavelengths, and thus several different frequencies.

A musical scale contains a series of notes that can be worked together into a melody.
Find the frequency, wavelength, and speed of every note in this scale.
Remember, that the speed is the same regardless of frequency and wavelength.
and everything is related by the formula $v = \lambda f$.

Remember:
- each note has a different frequency and wavelength!

- the speed is the same for each note!

- you need to used the formula $v = \lambda f$.

B.12 Physics of the C major scale

Note	Frequency (Hz)	Wavelength (m)	Speed (m/s)
C4 (do)	264		343
D4 (re)	297	1.15	
E4 (mi)		1.04	
F4 (fa)		0.97	
G4 (so)	396	0.87	
A4 (la)		0.78	
B4 (ti)	495		343
C5 (do)	528		

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Part C: Human Hearing

Hearing Range A newborn baby can hear all frequencies from 20 Hertz to 20,000 Hertz.
Age and hearing As people get older, they lose their ability to hear the *highest* frequencies (above 10,000 Hertz.

Hearing Range demonstration:

C.1 What is the highest note you can hear?

C.2 What is the highest frequency Mr. Kuncik can hear?

C.3 Who has better hearing? Why?

Ultrasonic Waves Sound waves with a frequency higher than humans can hear (greater than 20,000 Hertz).
Echolocation Dolphins and bats create ultrasonic waves which reflect off of objects in front of them in order to locate objects.
Ultrasound Imaging Medical technique that uses ultrasonic waves in order to see within a human body. Mimics the echolocation used by dolphins and bats.

Hearable or ultrasonic? For each sound wave, tell whether it can be heard or is ultrasonic?

C.4 330 Hertz
C.5 12,000 Hertz
C.6 50,000 Hertz (highest frequency heard by a dog)
C.7 25,000 Hertz