

# I THE NATURE OF WAVES: Do the wave!

## A. What is a wave?

1. Any disturbance that transmits energy through matter or empty space.
2. As a wave travels, it does work on everything in it's path.
3. Most waves transfer energy by the vibration of particles in a medium.
4. A medium can be a Solid, liquid or gas



## B. TYPE of WAVE (based on what it travels through)

### 1. Mechanical Wave:

a) This wave need a medium to travel.

b) Examples: Sound Ocean waves earthquake waves

### 2. Electromagnetic Wave:

a) This wave does NOT need a medium in order to travel, but it can also go through matter.

b) Examples: light x-rays Radio waves microwaves

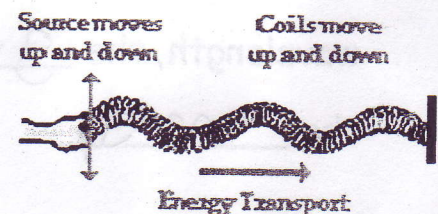
## C. TYPE of WAVE (based on how it moves)

### 1. Transverse Wave:

a) The particles of the medium move at right angles (perpendicular) to the direction the wave is moving.

b) Examples: electromagnetic waves  
ocean waves

### Transverse Wave



c) Parts of a transverse wave:





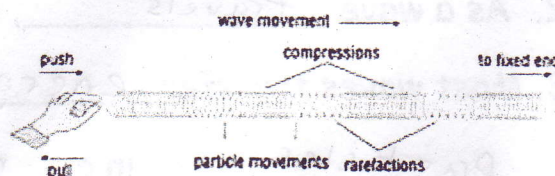
## 2. Longitudinal Wave:

a) The particles of the medium vibrate in the same directions  
(parallel) to the direction the wave is moving.

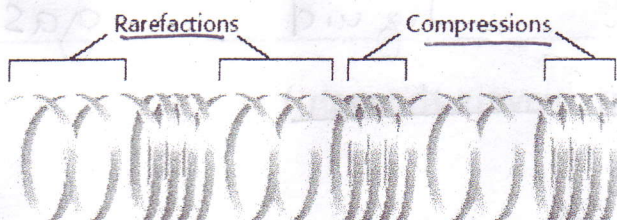
b) Examples:

Sound waves

P-waves



c) Parts of a longitudinal wave:

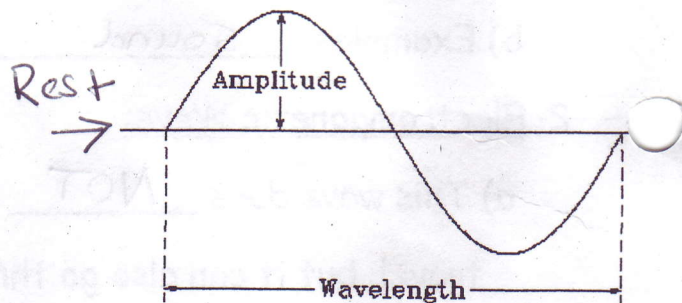


## II PROPERTIES OF WAVES:

### A. Amplitude:

"Surfs up dude"

1. It is the Maximum distance  
that the particles of a wave  
move from their rest position.



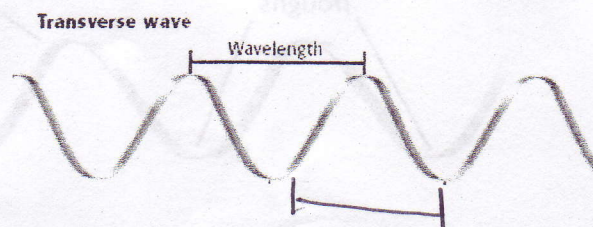
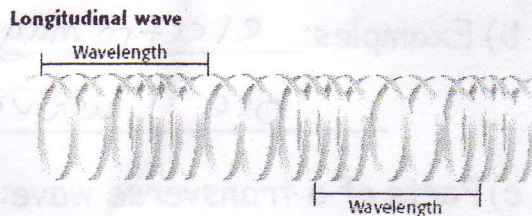
2. The greater the amplitude, the greater the energy.

### B. Wavelength:

1. The distance between two crests or two troughs.

2. The distance from compression to compression

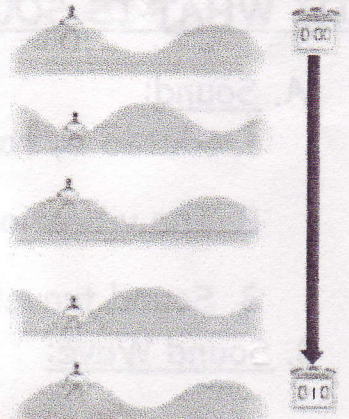
3. The Shorter the  
wavelength, the greater  
the energy.





C. Frequency:

1. The Number of waves produced in a given amount of Time
2. It is usually expressed in Hertz (Hz)
3. One Hertz equals one wave per second.
4. The higher the frequency, the more the energy.



Frequency can be measured by counting how many waves pass by in a certain amount of time. Here, two waves went by in 10 s, so the frequency is  $2/10 \text{ s} = 0.2 \text{ Hz}$ .

5. What is the frequency of a wave if 24 waves pass you in 12 seconds?

$$f = \frac{24}{12} \text{ sec}$$

$$2 \text{ Hz}$$

D. Wave Speed:

1. The speed at which a wave travels.
2. speed ( v ) = wavelength (  $\lambda$  )  $\times$  frequency ( Hz )

Example: What is the speed of a wave if it has a wavelength of 3 meters, and a frequency of 5 Hz?

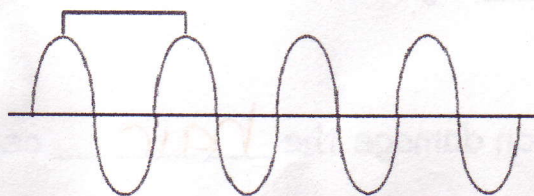
$$\begin{aligned} v &= \lambda \times \text{Hz} \\ &= 3 \times 5 \\ &= 15 \end{aligned}$$

$$15 \text{ m/sec}$$

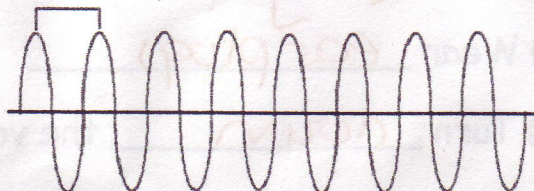
3. If a wave is traveling at a certain speed and you...

- a) double its frequency, its wavelength will be cut in half
- b) cut its frequency in half, its wavelength will double

Long Wavelength EM



Short Wavelength EM

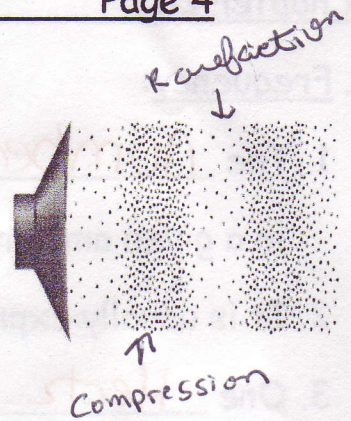




### III WHAT IS SOUND?

#### A. Sound:

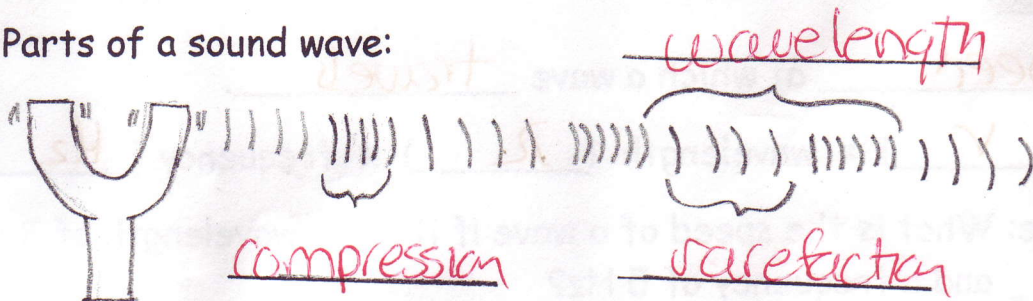
1. Caused by rapid vibration (back and forth)
2. The vibrations compress the air.
3. Sound travels outward from the source.



#### B. Sound Wave:

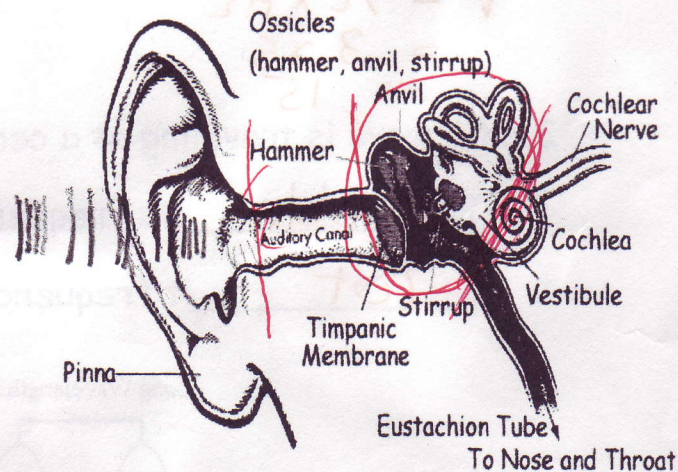
1. A compressional wave that needs to travel through a medium
  - \* Sound cannot travel in the vacuum of space!
2. The particles vibrate back and forth along the path that the sound wave travels.

#### 3. Parts of a sound wave:



#### C. Hearing Sound:

1. Outer ear collects the sound waves.
2. Middle ear increase vibrations with the hammer, anvil, stirrup
3. Inner ear changes vibrations into electrical signals.



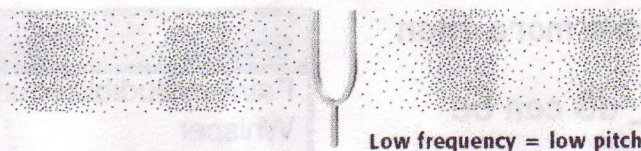
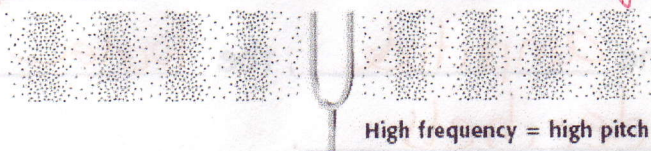
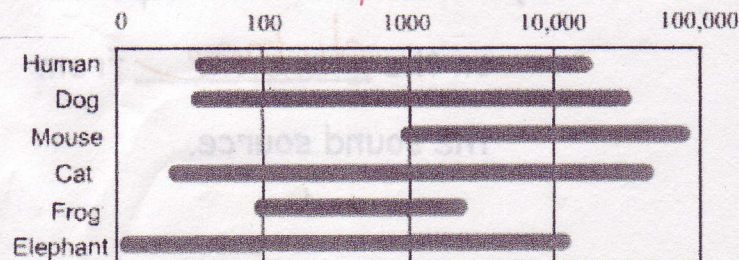
#### D. Hearing Loss:

1. loud sounds can damage the hair cells & nerve endings.
2. Tinnitus: a constant ringing in the ear.
3. Protect your ears !! a) Wear earplugs  
b) Turn down the volume !!



IV PROPERTIES OF SOUND:

## speed of sound

A. Speed of sound depends on:1. Type of matter:a) sound travels fasterin solids because they are denser.b) Different solids allow sound to travel at different speeds.2. Temperature:a) The hotter the medium, the faster the speed of sound.B. Pitch and Frequency:1. Frequency:a) The faster the vibration, the greater the frequency.2. Pitch:a) cannot be measured, but related to frequency.b) the higher the frequency, the higher the pitch.3. Different animals hear different frequency ranges.a) Ultrasonic: sounds that have a frequency too high to hear by humans.b) over 20,000 Hz



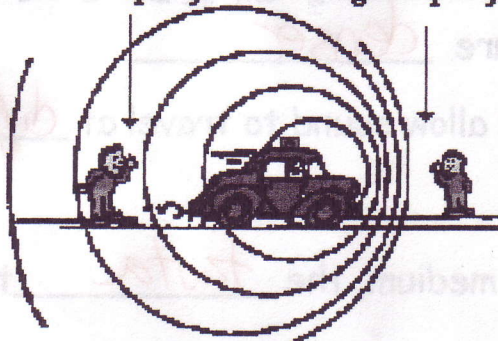
## 4. Doppler Effect:

a) When the pitch of a sound changes due to the moving of...

\* the sound source \* the listener

Long Wavelength  
Low Frequency

Small Wavelength  
High Frequency



The Doppler Effect for a moving sound source

b) The police car compresses the sound waves together causing a higher frequency and a pitch

c) As the car moves away the pitch drops

## C. Loudness and Amplitude:

1. A sound is loud if it has a lot of energy.

2. The greater the amplitude, the louder the sound.

3. Measured in decibels.

a) Sounds that are more than

120 dB can be

painful

b) Decibel level also depends

on the distance from

the sound source.

Source	SPL(dBA)
Faintest audible sound	0
Whisper	20
Quiet residence	30
Soft stereo in residence	40
Speech range	50-70
Cafeteria	80
Pneumatic jackhammer	90
Loud crowd noise	100
Accelerating motorcycle	100
Rock concert	120
Jet engine (75 feet away)	140



## V INTERACTIONS OF SOUND WAVES:

### A. Reflections of Sound Waves:

1. Echo: The reflection of sound waves.

a) Sound waves reflect best off of smooth, hard surfaces.

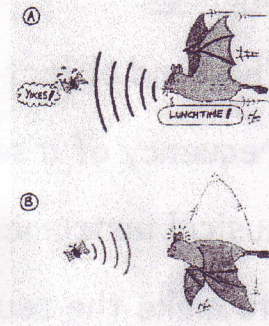
b) Well designed auditoriums, absorb echoes by using soft materials and irregular shapes that scatter sound waves.

c) Reverberation: mixture of reflected sounds.

### 2. Echolocation:

a) Using reflected sound waves to find objects.

b) Bats use this along with the doppler effect to catch moving bugs.



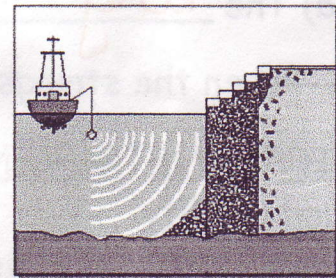
### 3. SONAR:

a) SO UND

N AVIGATION

A ND R ANING

b) a type of electronic echolocation



### 4. Ultrasound Technology:

a) Using ultrasonic waves that reflect off of a person's organs such as kidneys and gallbladders.

### B. Interference of Sound Waves:

1. When 2 or more waves combine.

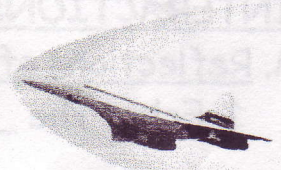
a) Constructive: Sound is louder due to amplitude increase.  
Compressions overlap compressions.

b) Destructive: Sound is softer due to amplitude decrease.  
Compressions overlap rarefactions.



## 2. Sound Barrier:

- a) When a jet reaches the speed of sound,  
the sound waves in front of the jet combine by  
constructive interference.



Sound Barrier

- b) This high density compression is called the sound barrier.  
c) Sonic boom: explosive sound

## C. Resonance:

1. When an object vibrating at or near a resonant frequency of a second object causes that object to vibrate.

2. Musical instruments use resonance to make the sound fuller.

- a) The body of the guitar resonates when the strings are strummed.



## VI MUSICAL INSTRUMENTS:

## A. Sound Quality:

1. Each instrument has a unique ~~different~~ sound quality due to their structure differences.

## B. String Instruments:



1. Strings of different thicknesses cause different pitch  
2. String length changes pitch. Short string causes high pitch.

## C. Wind Instruments:



1. Produce sound when the air column vibrates.  
2. Valves control the length of the air column

## D. Percussion Instruments:



1. Make sound when hit.  
2. The bigger the instrument, the lower the pitch.