SOUND

Objectives

- Understand the idea of sound and hearing
- Learn how sound travels through media
- Explain how the ear works, find out about the harmful effects of loud noise and how loud noise can be reduced

Key Terms

- Loud
- Soft
- Quiet
- High pitch
- Low pitch
- Noise
- Deafness
- Frequency
- Amplitude
- Wave
- Loudness
- Volume
- Dynamics
- Medium
- Speed of sound

The Facts

Sound …

1. Is a form of energy produced & transmitted by vibrating matter
2. Travels in waves
3. Travels more quickly through solids than liquids or gases

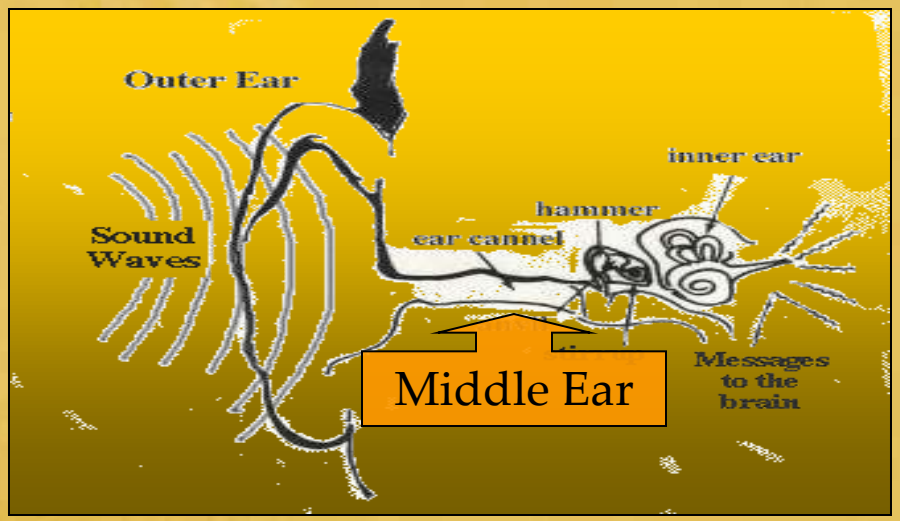
- The denser the medium, the faster sound will travel.
- The higher the temperature, the faster the particles of the medium will move and the faster the particles will carry the sound

Table 1 Speed of Sound in Different Mediums

Medium	Speed of Sound (in m/s)
Air	347
Cork	500
Water	1,498
Brick	3,650
Aluminum	4,877

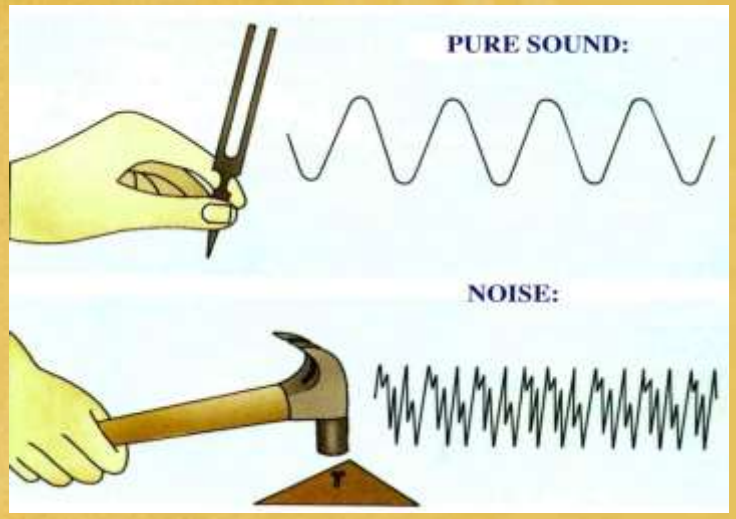
The Ear

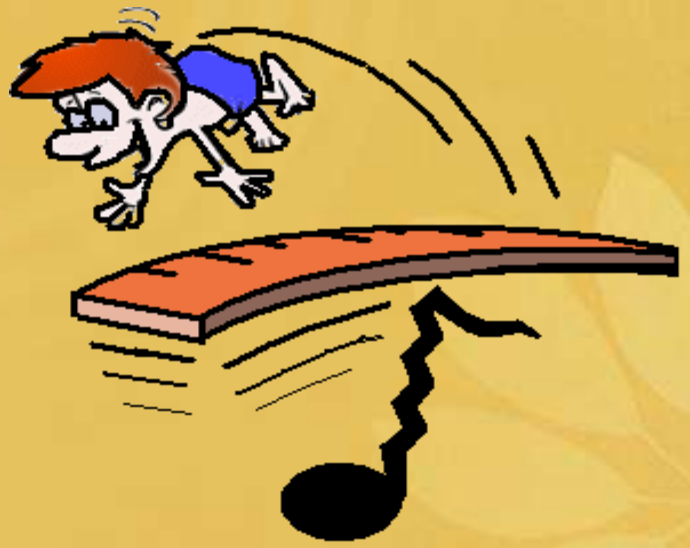
- Sound is carried to our ears through vibrating air molecules.
- Our ears take in sound waves & turn them into signals that go to our brains.



Vibration

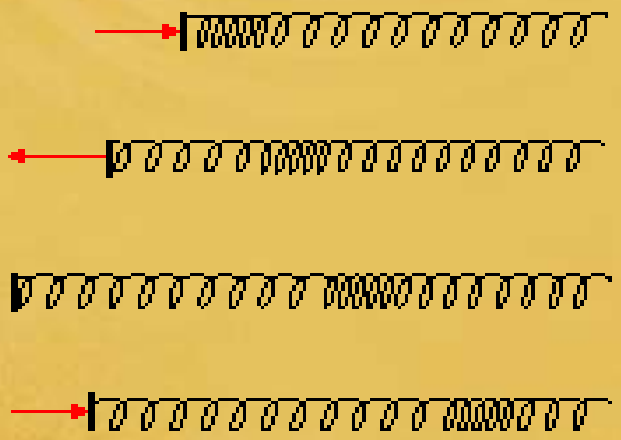
- Back and forth movement of molecules of matter
- For example,





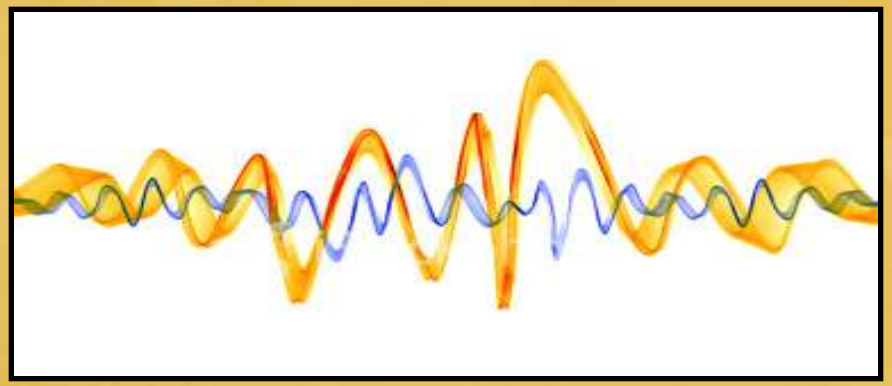
Compression

- Where molecules are being pressed together as the sound waves move through matter
- For example,
  - a wave travels through the springs just like sound waves travel through the air
  - the places where the springs are close together are like compressions in the air.



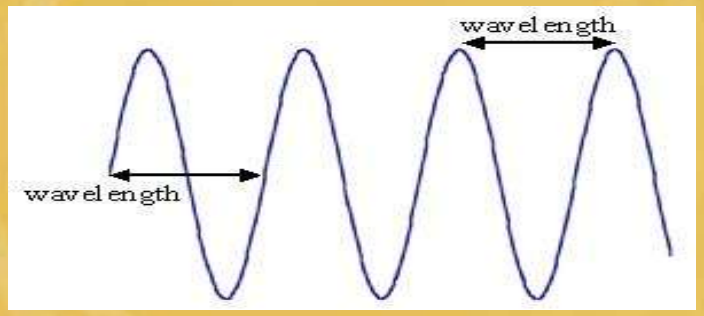
Sound Waves

- Alternating areas of high & low pressure in the air
- ALL sound is carried through matter as sound waves
- Sound waves move out in ALL directions from a vibrating object

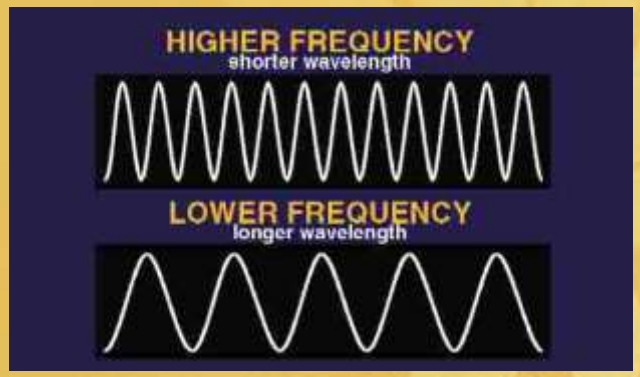


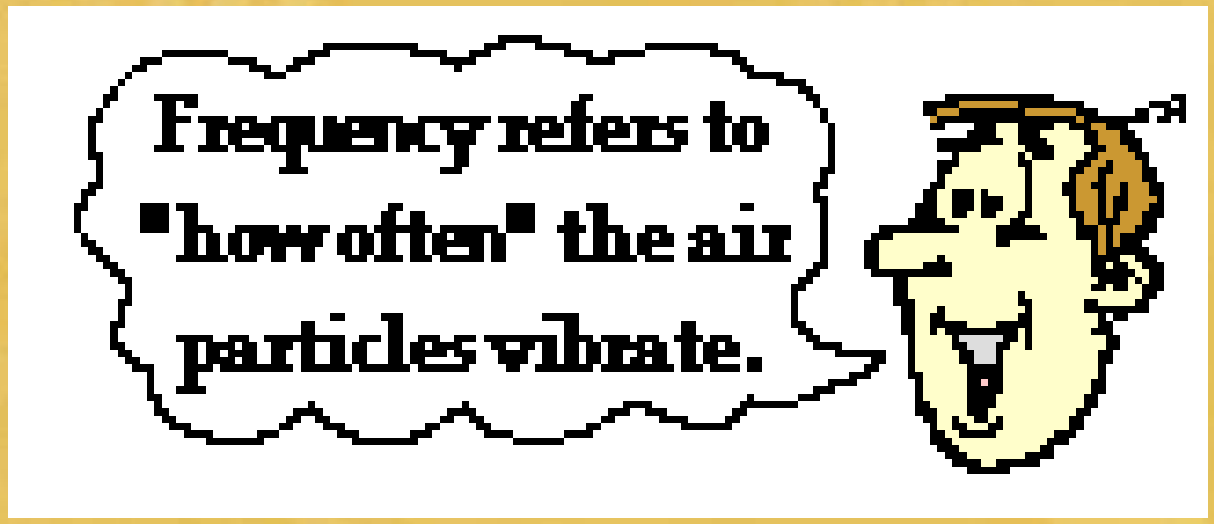
Wavelength & Frequency

- Wavelength is the distance between one part of a wave and the same part of the next wave

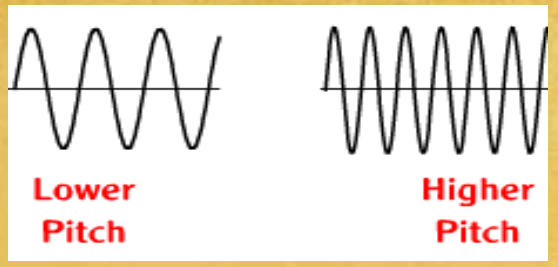


- Frequency is the number of waves moving past a point in one second

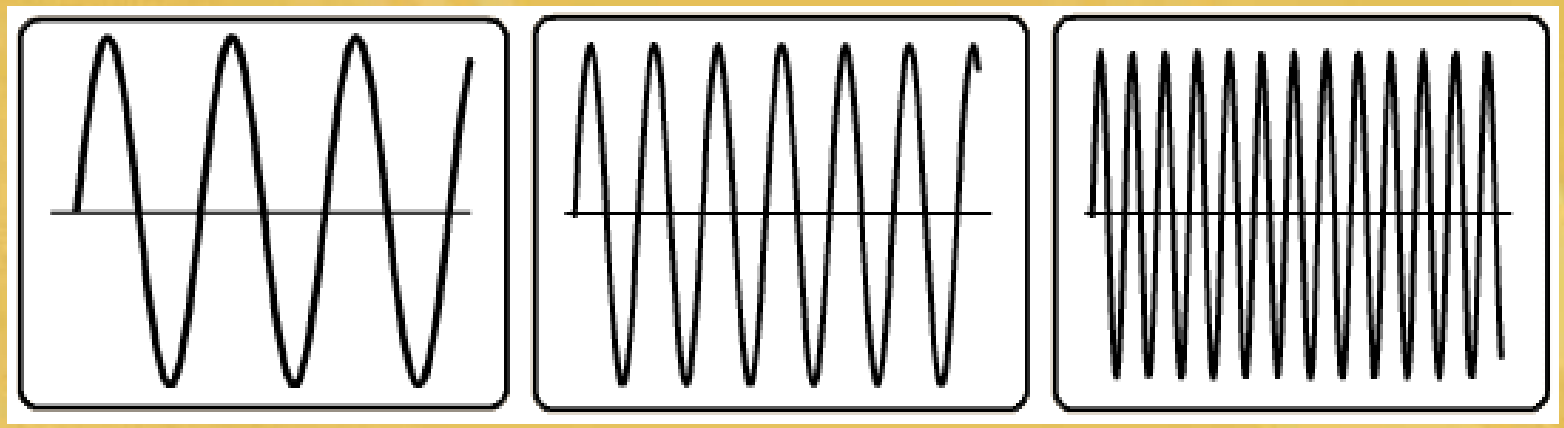



Frequency refers to "how often" the air particles vibrate.

Pitch



- A measure of how high or low a sound is
- Pitch depends on the frequency of a sound wave
- For example,



- Low pitch

- Low frequency

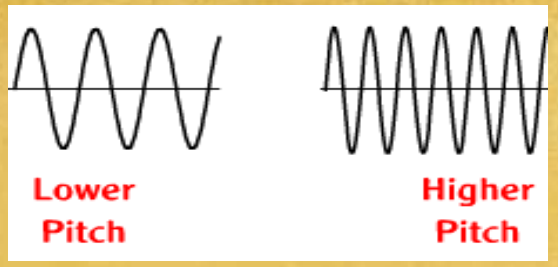
- Longer wavelength

- High pitch

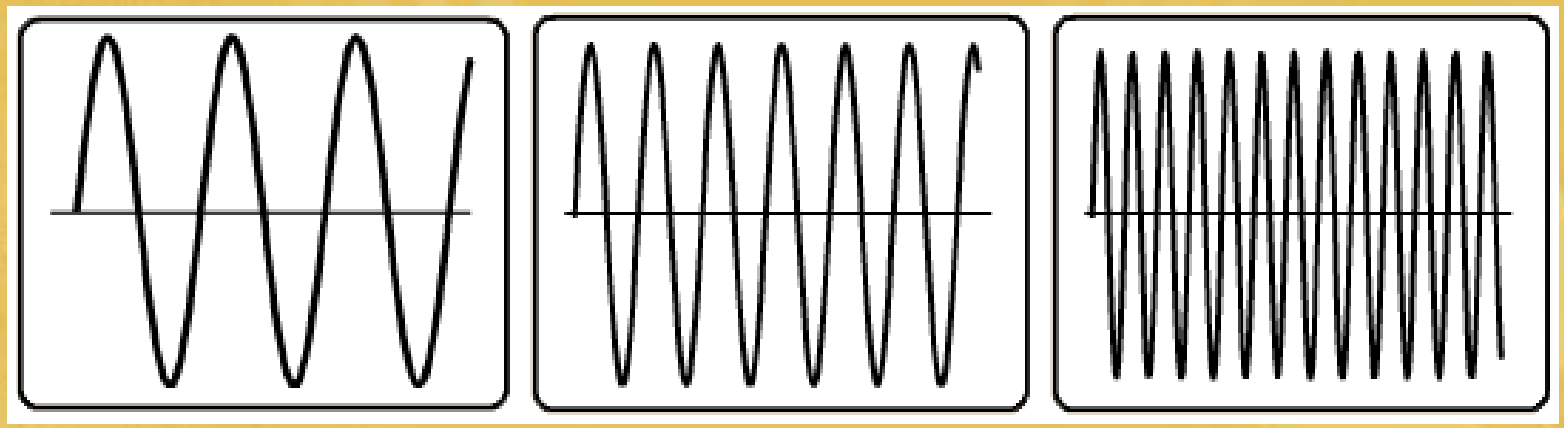
- High frequency

- Shorter wavelength

Pitch



- When an object vibrates faster they make a higher pitch sound



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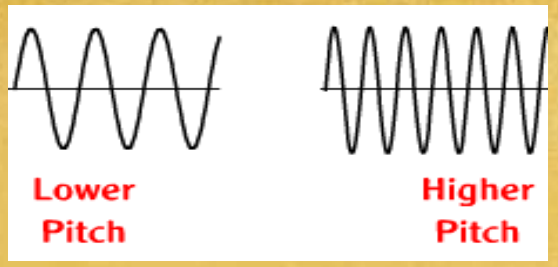
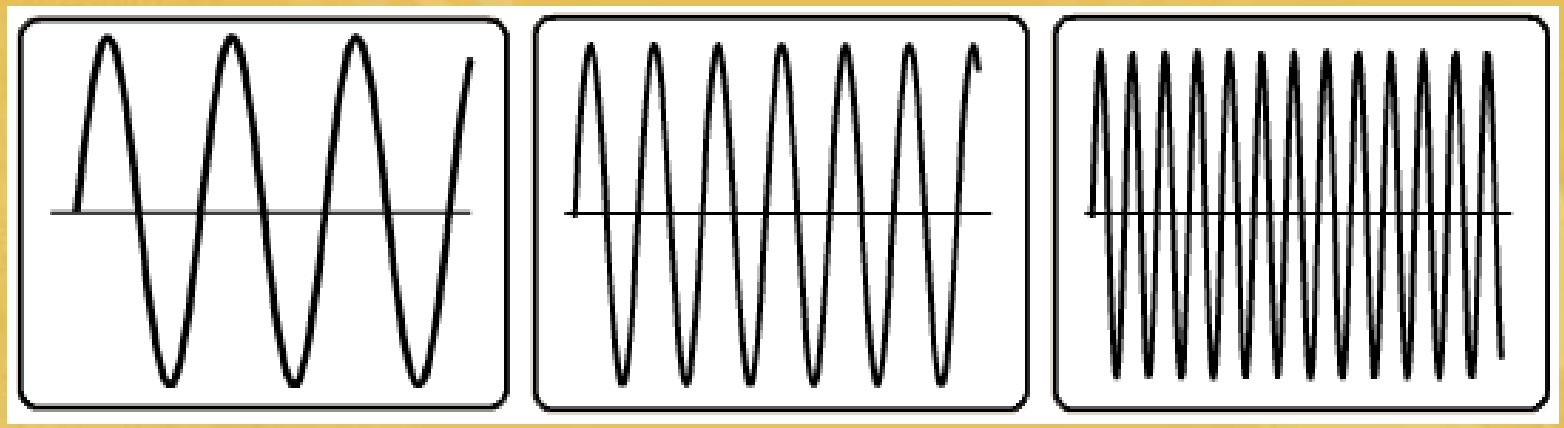
Pitch



- Pitch is measured in Hertz (Hz)



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- Low frequency

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Pitch

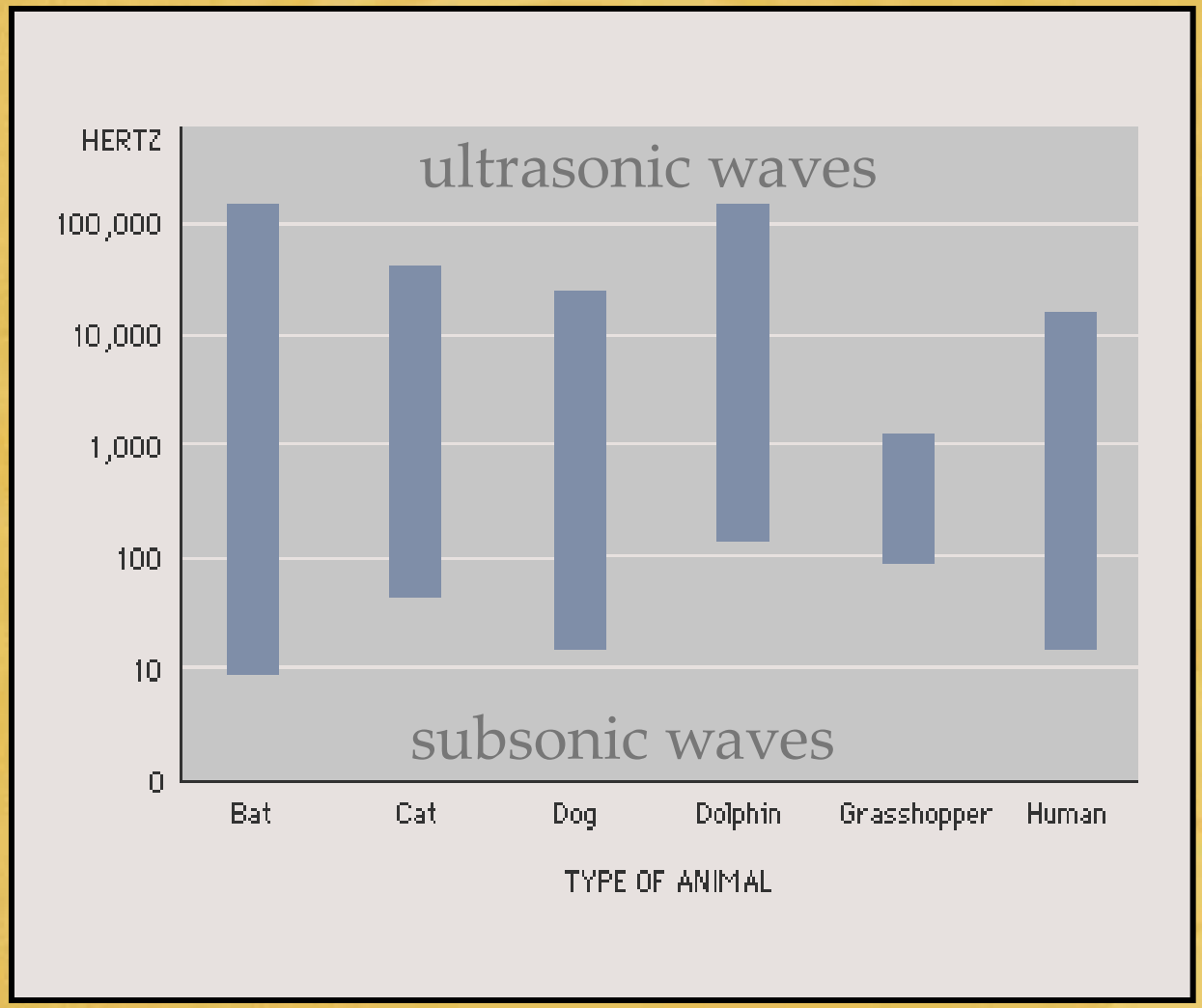
- **1 Hertz = 1 vibration/second**

How is frequency related to pitch?

- The pitch of a sound wave is directly related to frequency.
- A high-pitched sound has a high frequency (a screaming girl).
- A low-pitched sound has a low frequency (a fog-horn).

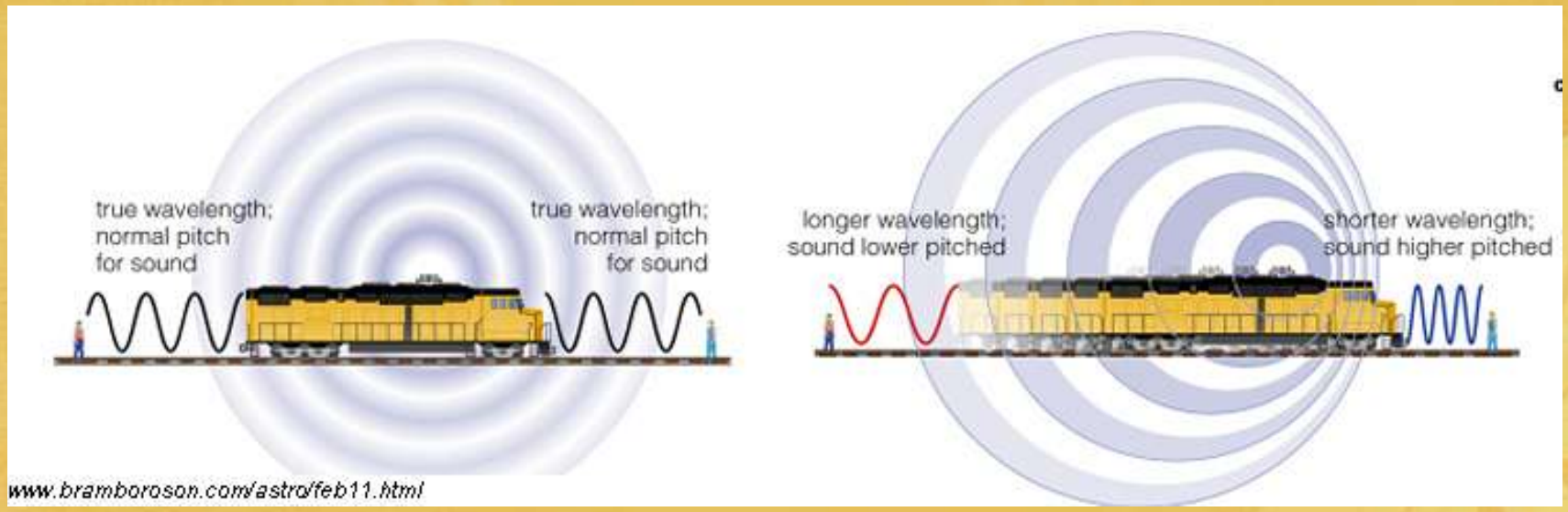
- A healthy human ear can hear frequencies in the range of **20 Hz to 20,000 Hz**.
- Sounds below this frequency are termed ***subsonic***.
- Sounds above 20,000 Hz are termed ***ultrasonic***. Some animals, such as dogs, can hear frequencies in this range in which humans cannot hear.

Pitch


HERTZ
100,000
10,000
1,000
100
10
0
ultrasonic waves
subsonic waves
Bat
Cat
Dog
Dolphin
Grasshopper
Human
TYPE OF ANIMAL

What is the *Doppler Effect*?

- The ***Doppler Effect*** is the apparent change in frequency detected when the sound is moving relative to the hearer.



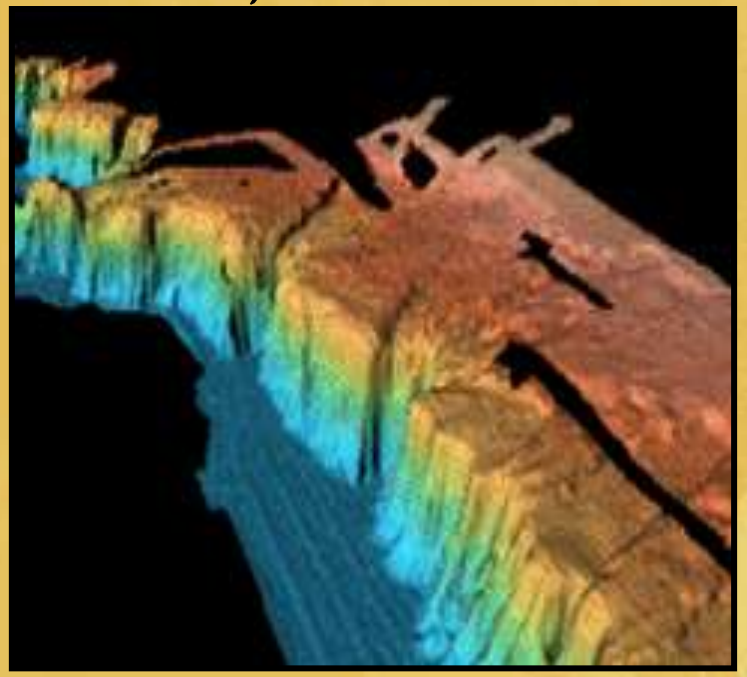
Ultrasound

- Because ultrasound is such a high frequency it is easy to direct the sound waves for use
  - Medicine
  - Dentistry
  - Cleaning
  - Oil exploration
  - Cracks in metal

"Seeing" with Sound

- **Ultrasonic waves** - above 20,000 Hz

Medical Imaging



SONAR

"Sound Navigation

What is echolocation?

Many bats emit ultrasonic—very high-frequency—sounds. The sound waves bounce off objects, and bats locate prey by using the returning echoes. Known as echo-location, this technique is also used by dolphins, which produce clicking sounds as they hunt. The diagrams below show how a bat uses echolocation to capture a flying insect.

A Sound waves of a bat's ultrasonic cries spread out in front of it.

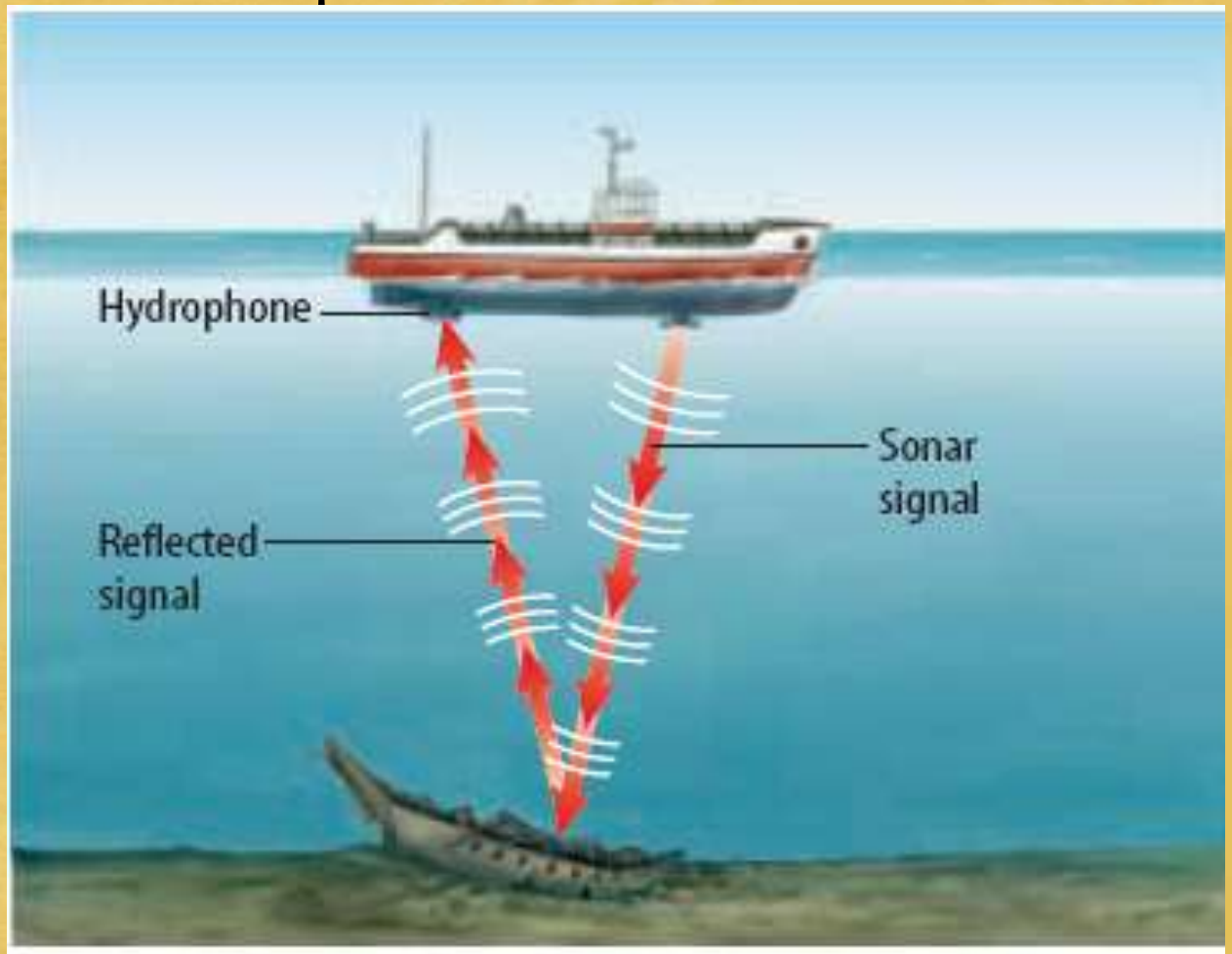
B Some of the waves strike a moth and bounce back to the bat.

C The bat determines the moth's location by continuing to emit cries, then changes its course to catch the moth.

D By emitting a continuous stream of ultrasonic cries, the bat homes in on the moth and captures its prey.

What is sonar?

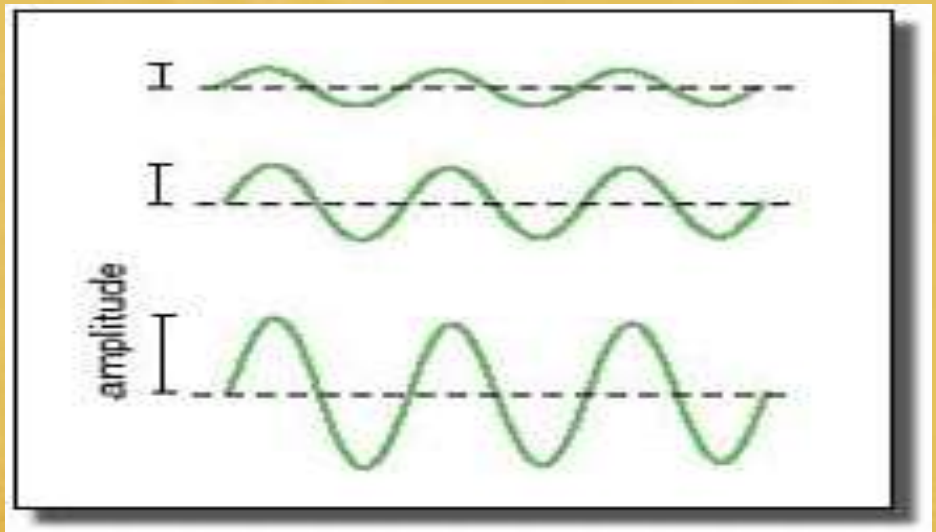
Sonar is a system that uses the reflection of underwater sound waves to detect objects. This has been used to find sunken ships and schools of fish.



Sonar uses sound waves to find objects that are underwater.

Amplitude

- A measure of the amount of energy in a sound wave
- Amplitude depends on the height of a sound wave
- For example,



-Low amplitude

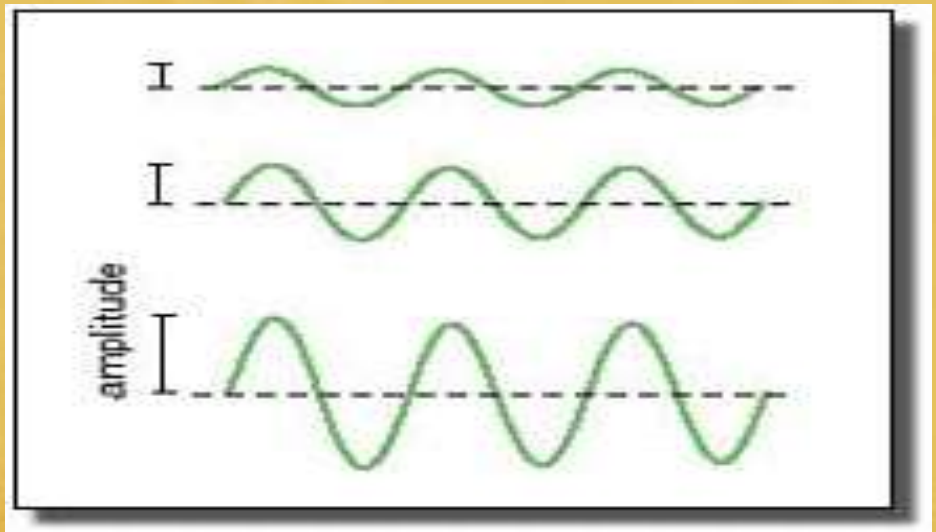
- Long wavelength

- High amplitude

- Long wavelength

Amplitude

- Amplitude shows how far the particle has moved from it starting position
- Amplitude is half the total height of the wave



-Low amplitude

- Long wavelength

- High amplitude

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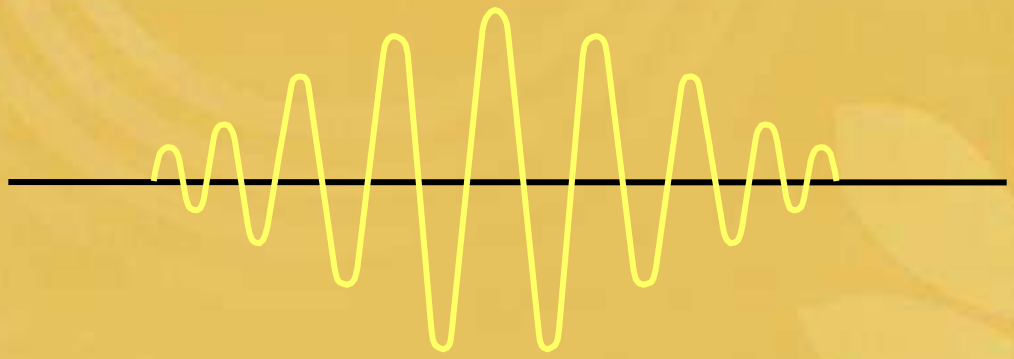
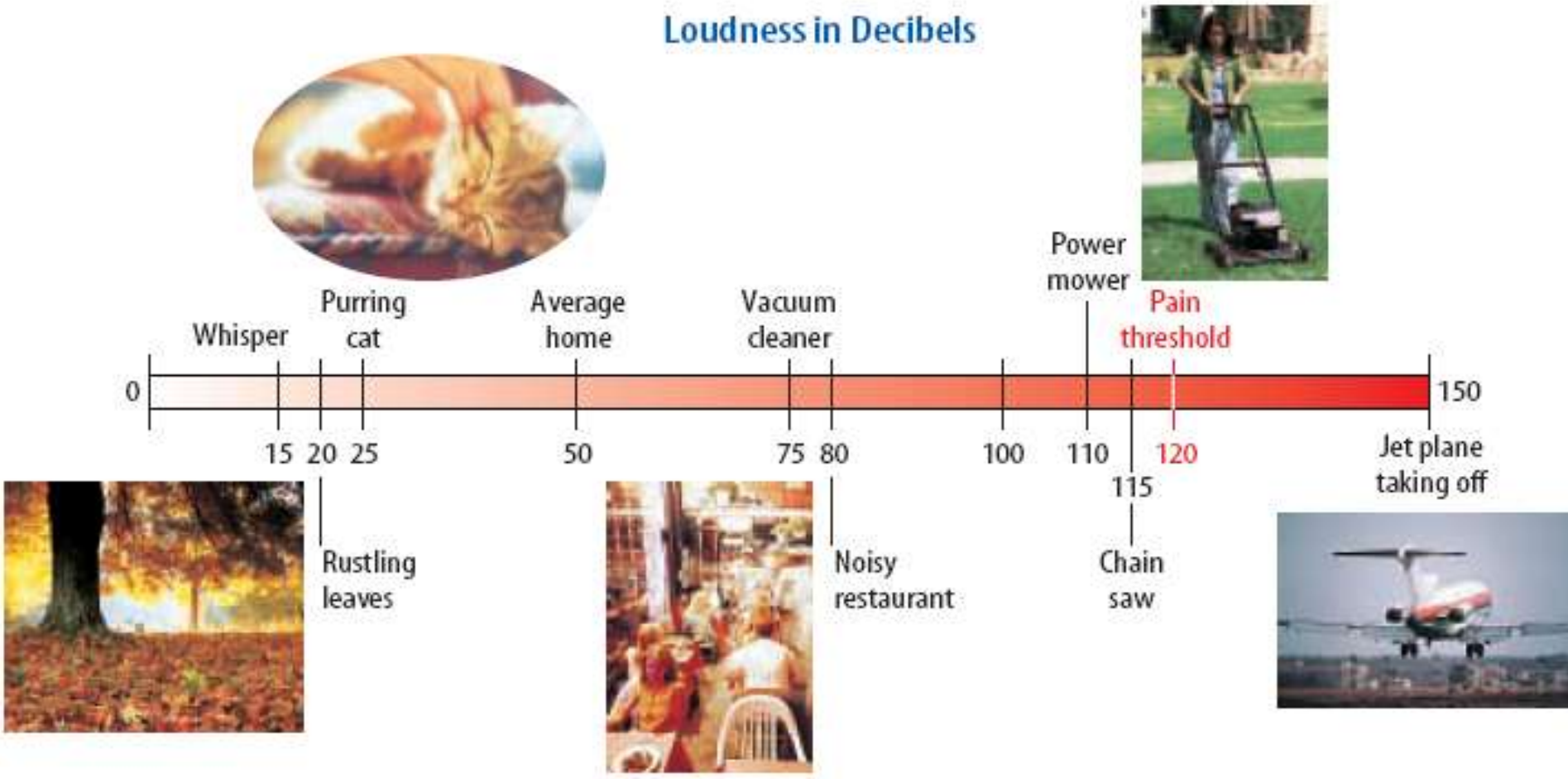
Amplitude

- Measured in decibels (dB)



Loudness in Decibels



Sound and Instruments

- Instruments can be played at different pitches by changing lengths of different parts.

- For example,
- Another way to make different pitches is to change the thickness of the material that vibrates.
- For example,

A trombone's mute absorbs some of the sound waves produced, thus producing a softer note when played.

Using Sound

What is *Acoustics*?

Acoustics is the study of sound and ways to optimize the hearing of sound inside various structures.

This concert hall uses cloth drapes to help reduce reverberations.

Your Instrument

- Should be:
  - Well designed
  - Simple
  - Functional
  - Attractive
  - Creative
- You must be able to:
  - Produce Sound
  - Change Pitch
  - Change Volume