The Physics Of Sound

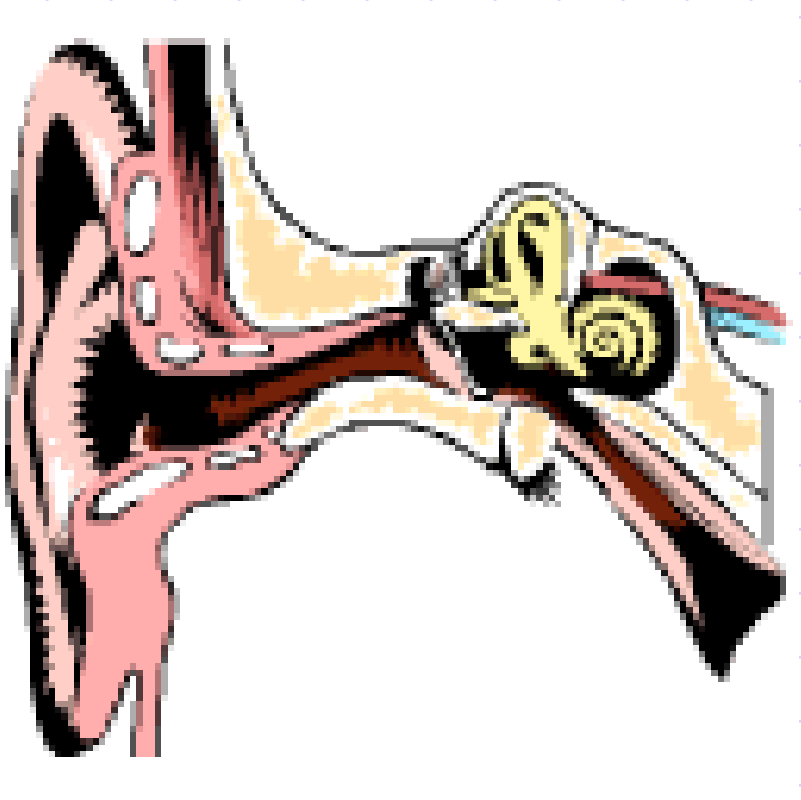
Why do we hear what we hear?

(Turn on your speakers)

Sound is made when something vibrates.

- The vibration disturbs the air around it.
- This makes changes in air pressure.
- These changes in air pressure move through the air as sound waves.

The sound waves cause pressure changes against our ear drum sending nerve impulses to our brain.



This is similar to throwing a rock into a pond.

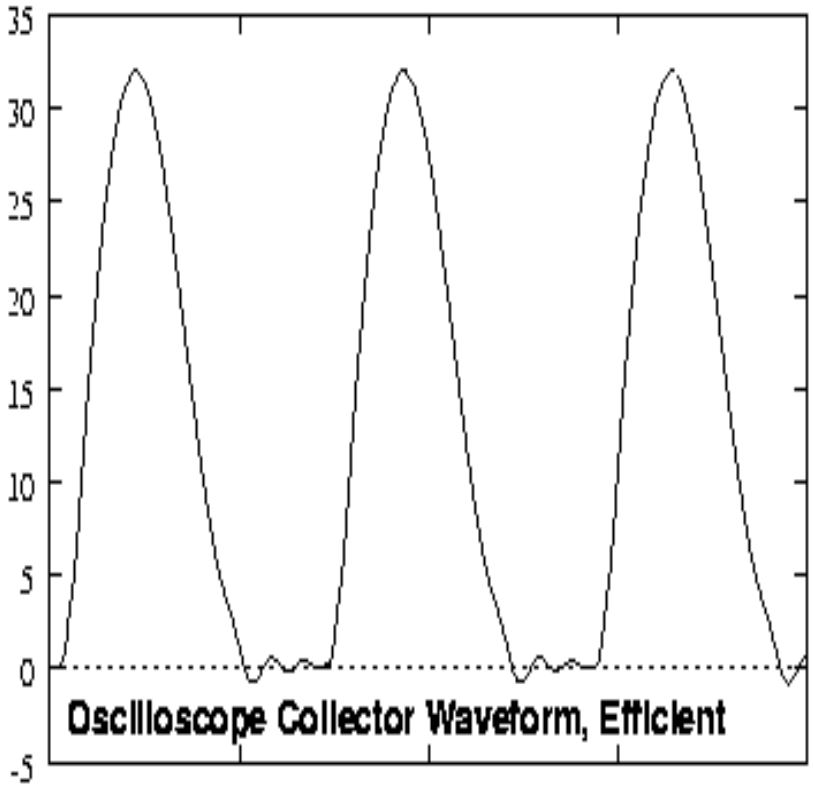
Air molecules ripple through the air in sound waves like water waves rippling across a pond.

The three components of sound are:

- Pitch (how high or low)
- Loudness (volume)
- Timbre (tone color)

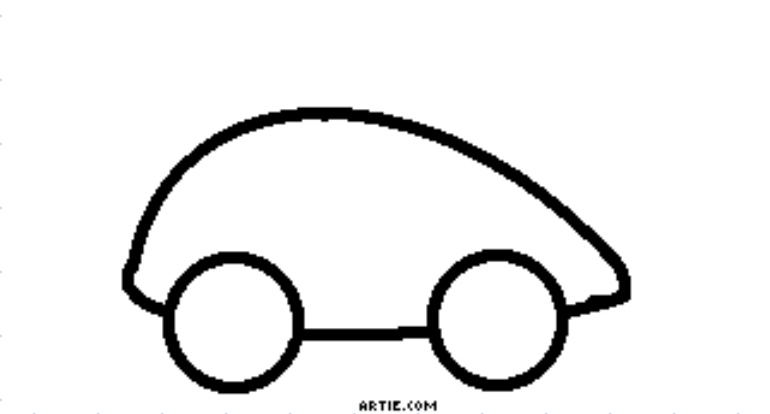
Pitch

- The vibration patterns of some sounds are repetitive
- Vibration patterns are also called waveforms.
- Each repetition of a waveform is called a cycle.
- We can hear frequencies between 20 hertz or cycles (vibrations) per second (low pitches)to 20 kilohertz, i.e. 20,000 Hz (high pitches).



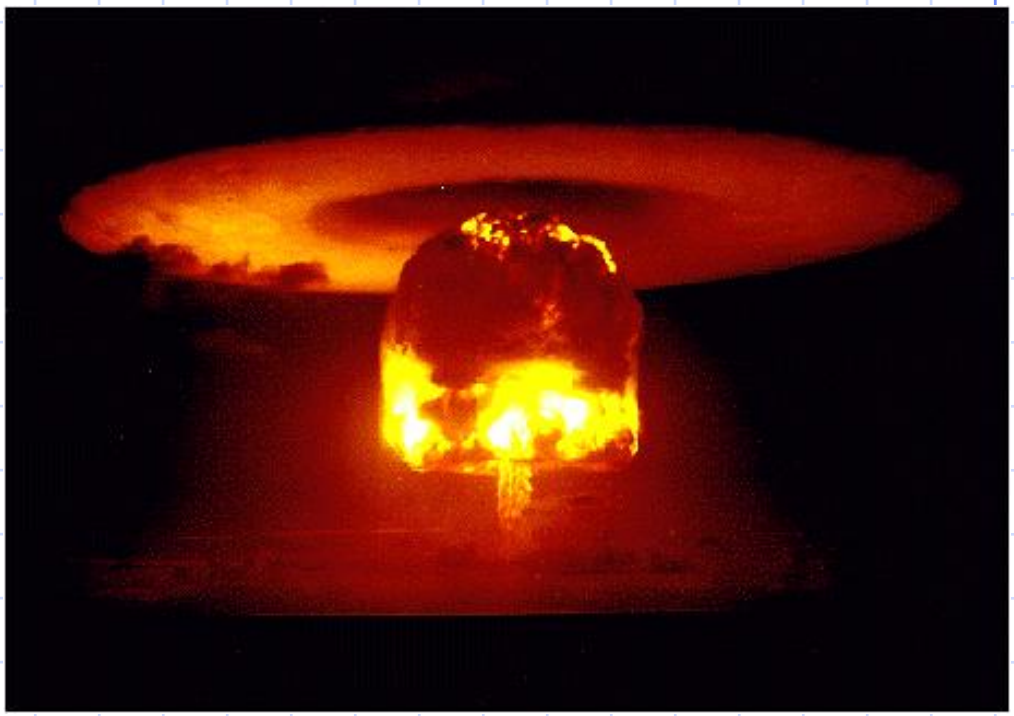
- When the frequency of a sound doubles we say that the pitch goes up an octave.
- We can hear a range of pitches of about ten octaves.
- Many animals can make sounds and hear frequencies that are beyond what we can hear.

Loudness



- To create vibrations energy is used.
- The greater amount of energy used the louder the sound.
- The strength of the changes in air pressure made by the vibrating object determines loudness.

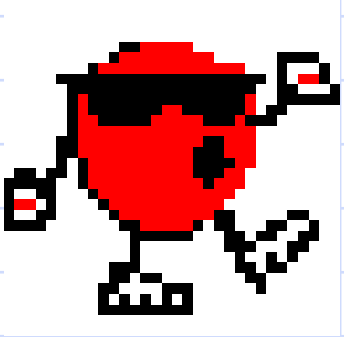
- As the sound spreads out from its source, the concentration of power becomes less.
  - As the distance from the source increases the amount of power is spread over a greater area.
  - The amount of power per square meter is called the **intensity** of the sound.



Humans do not perceive sound intensity linearly.

- For us to perceive a sound as twice as loud its intensity must be ten times greater.
- The perceived intensity level of sound is measured in a logarithmic scale using a unit called the decibel (dB)

The scale begins (0 dB) on the softest sound that a person can hear. This is called the threshold of hearing.



The scale ends at the volume that causes pain (120 dB) and is therefore called the threshold of pain.

From the perspective of the logarithmic scale the threshold of pain is

1,000,000,000,000

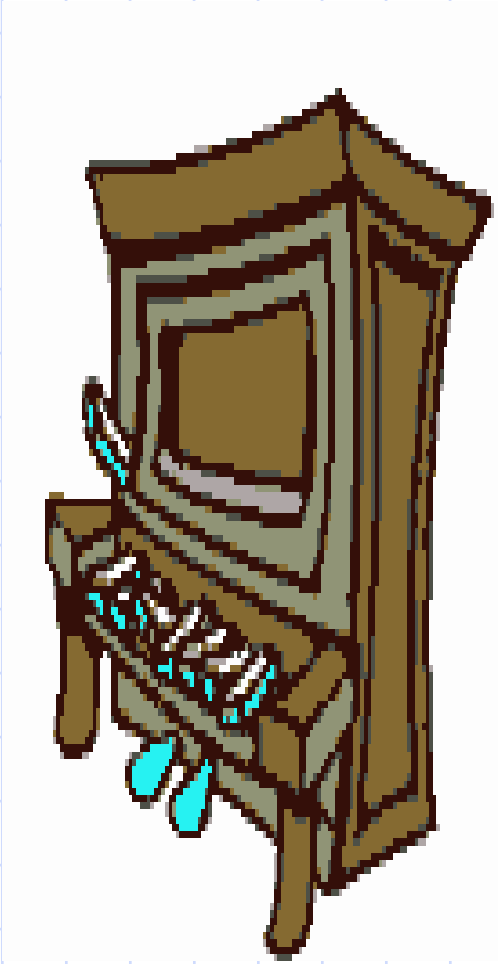
times as great as the threshold of hearing.

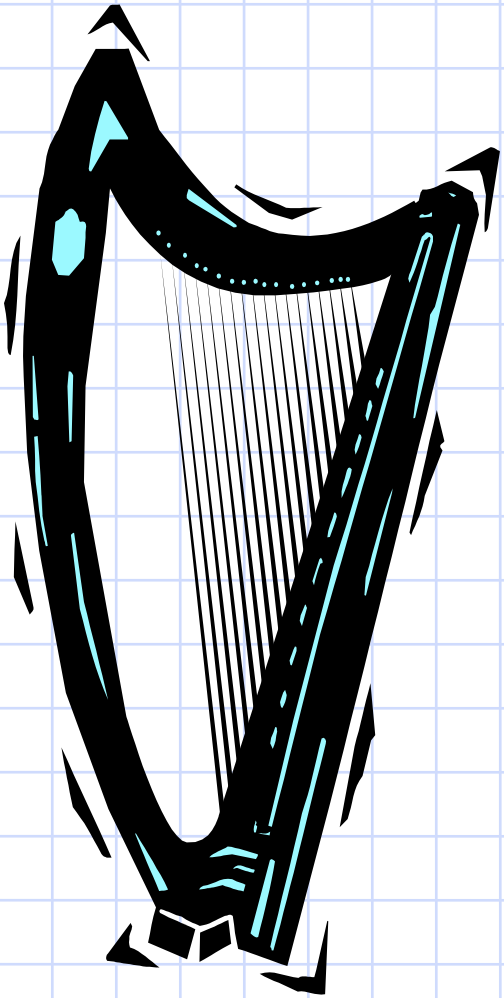
decibels	Danger Zone
150	Jet Take-Off
140	Gun Shot
130	Jack-Hammer, Rock Concert
120	Car Stereo, Band Practice
110	Dance Clubs, Headphones
100	Factory
90	Subway
80	Busy Street
70	Restaurant
60	Conversation

- The picture above is a wave file of someone singing.
- The chart on the left is a representation of different sounds around us and their volume in decibels.

“Timbre” (TAM-ber) or tone color

- is the specific property of sound that enables us to determine the difference between a piano and a harp.



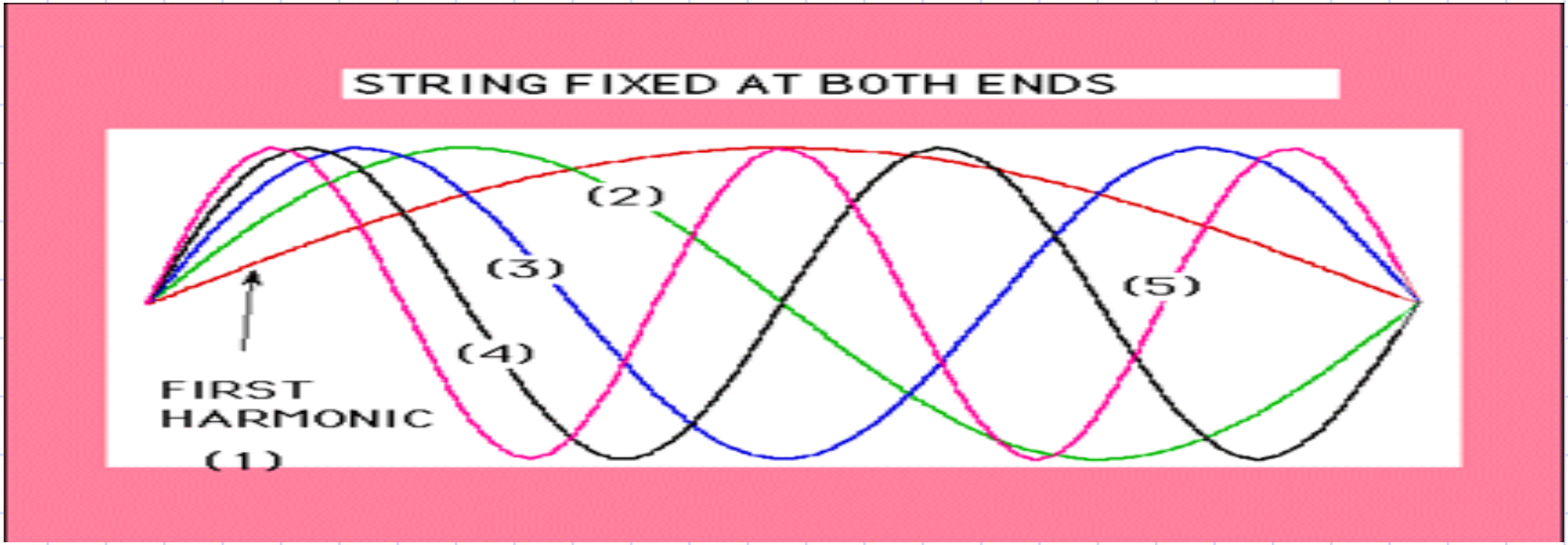


An extremely broad variety of tone colors exist because most sounds that we perceive as pitch actually contain many frequencies.

The predominant pitch is called the **fundamental** frequency.

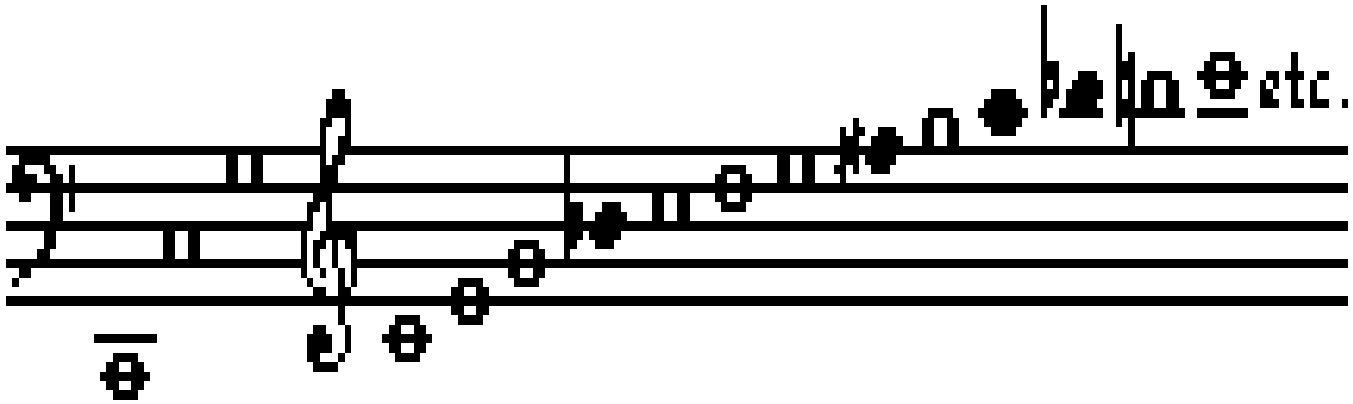
Although we would perceive a string vibrating as a whole,

it actually vibrates in a pattern that at first appears to be erratic producing many different overtone pitches. What results are particular tone colors or timbres of instruments and voices.



The other frequencies which occur in a mathematical series are called the **harmonic** or **overtone series.**

When C1 is the fundamental the following pitches represent its first fifteen successive overtones.



I hope you enjoyed my presentation.

I hope it made you happy…