

## *Acoustics*

- Waveform
- Frequency
- Intensity
- Resonance
- Sound Propagation

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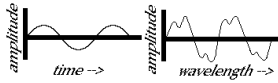
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## *Waveform*

- X-axis (time or wavelength)
- Y-axis (amplitude)



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## *Frequency*

- Refers to how many oscillations (i.e., back and forth vibrations) occur during 1 second.
- Older term for frequency was cycles per second.
- Current term for frequency is Hertz (Hz).

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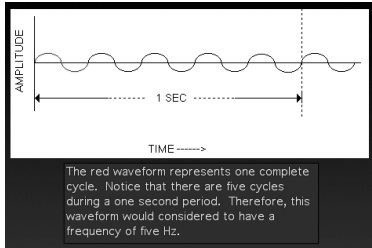
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## Frequency



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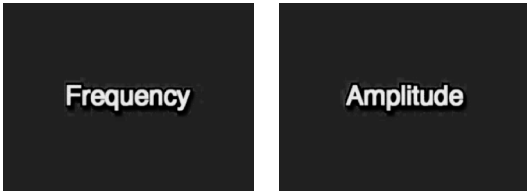
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## Example of Frequency & Intensity



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## Frequency

- Different frequencies are perceived as different pitches.
- Young normal hearing people can hear frequencies between 20 and 20000 Hz.
- Most important speech sounds range between 500 to 6000 Hz.
  - 500 Hz 
  - 1000 Hz 
  - 2000 Hz 
  - 6000 Hz 

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*Intensity*

- The scale used to measure intensity is the decibel (dB).
- Non-linear scale... that is, doubling intensity only increased overall dB level by 6 dB.
  - e.g.,  $30 + 30 = 36$  dB....  $50 + 50 = 56$  dB

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*Intensity*

- 20 dB Whisper
- 30 dB Soft speech
- 50 dB Normal conversational speech
- 70 dB Loud speech
- 90 dB Shouting
- 100 to 120 dB rock band
- 120 dB threshold of pain
- 140 dB jet engine or high powered rifle

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*Intensity*

- Loud sounds can damage hearing.
- OSHA requires workers working in environments above 90 dB to wear ear protection.
- Incidence of noise induced hearing loss is increasing among younger people.

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### *Intensity*

- Examples of dangerous noise sources...
  - Firearms, chainsaws, music (especially for musicians, bartenders, waiters/waitresses,), racecars, snowmobiles, etc.
- Only effective ear protection are foam earplugs and ear muffs.

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### *Resonance*

- Definition: vibratory response to an applied force.
- Resonator: An object which causes air molecules to resonate.
  - Examples: tuning forks, vocal tracts, ear canal, guitar string, pop bottle, etc.
- Resonate Frequency: Frequency where the greatest amplification (resonates) occurred.

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### *Resonators*

- Wavelength Resonator
  - A tube.... Length will determine resonant frequency.
  - Examples include: Trombone, vocal tract, ear canal.



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## *Resonators*

- **Hemholtz Resonator**
  - Enclosed capsule of air.... Size of hemholtz resonator determines resonant frequency.
  - Examples include: jug, parts of the vocal tract.



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## *Sound Propagation*

- Deals with how sound travels.
- **Sound Production:** Begins when force causes an object to vibrate causing adjacent air particles to vibrate.
  - tuning forks, vibrating vocal folds, etc.
- After air particles begin to vibrate they literally bounce into one another and a sound wave occurs.

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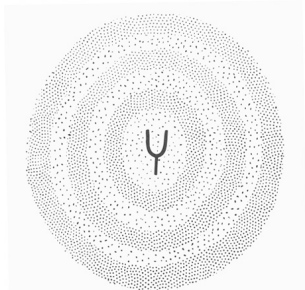
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**Figure 3.9.** Pressure wave emanating from a sound source. (The areas of compression should encircle the vibrator as a globe, a representation not indicated in this two-dimensional figure.)

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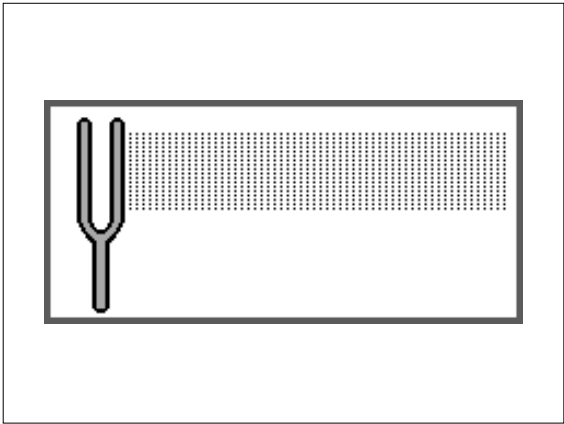
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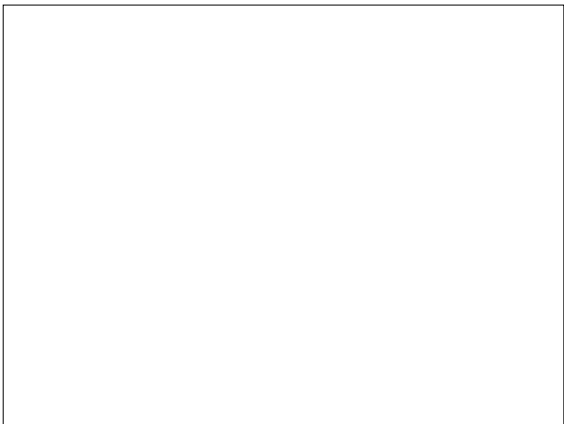
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