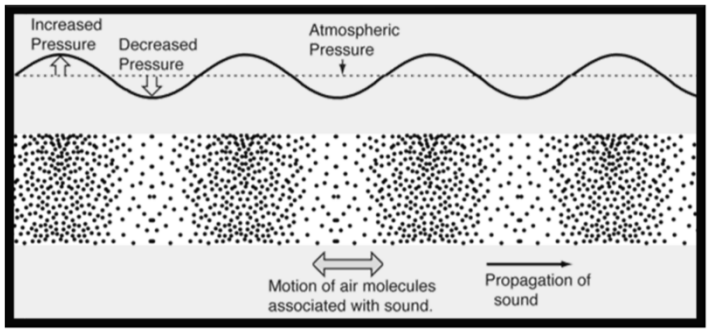
SOUND WAVES

1

Sound

- A source, like a speaker, compresses air molecules at regular intervals, creating differences in pressure over time.
- This creates a **longitudinal wave**



2

Speed of Sound

- The speed of a sound wave depends on the medium.

Speed of sound in various substances (CRC Handbook)

Gasses (*0°C*)	Substance	Speed of Sound (*m/s*)
	Carbon Dioxide	259
	Hydrogen	1284
	Helium	965
	Nitrogen	334
	Oxygen	316
	Air (21% Oxygen, 78% Nitrogen)	331
	Air (20°C)	344
Liquids (*25°C*)	Glycerol	1904
	Sea Water (3.5% salinity)	1535
	Water	1493
	Mercury	1450
	Kerosene	1324
	Methyl Alcohol	1103
	Carbon Tetrachloride	926
Solids	Diamond	12000
	Pyrex Glass	5640
	Iron	5960
	Granite	6000
	Aluminum	5100
	Brass	4700
	Copper (annealed)	4760
	Gold	3240
	Lead (annealed)	2160
	Rubber (gum)	1550

3

Speed of Sound

- Speed of sound in air = 331 m/s @ 0^o C
- In air, speed increases 0.6 m/s for each 1^oC increases in temperature
- Velocity at any temperature can be found using: $v = 331 + 0.6T_c$
- Follows all properties of waves including:

$$v = \lambda f$$

- Wavelength, <u>not frequency</u>, changes when a wave changes speed

4

Speed of Sound Example

- A 281 Hz sound wave travels through 33.0ºC air. What is the wavelength of the wave?

  $v = 331 + 0.6(T_c)$

  $v = 331 + 0.6(33)$

  $v = 350.8$ m/s

  $v = \lambda f$

  $350.8 = (\lambda)281$

  Answer: 1.25 m

5

Speed of Sound Example #2

- A sound wave has a frequency of 225.0 Hz and a wavelength of 1.55 m. At what temperature is this wave traveling?

  $v = \lambda f$

  $v = 1.55(225)$

  $v = 348.75$ m/s

  $v = 331 + 0.6(T_c)$

  $348.75 = 331 + 0.6(T_c)$

  $17.75 = 0.6(T_c)$

  $T_c = 29.58$ ºC

6

Pitch

- How high or low the perceived sound is
- Based on the frequency of sound
  - High frequency = High pitch
  - Low frequency = Low pitch

7

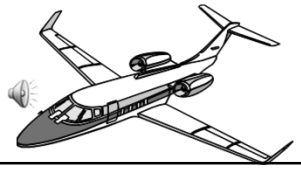
Pitch – the sound spectrum

- Humans can hear frequencies between 20 Hz and 20,000 Hz. These are called the audible sound waves.
- Sounds below 20 Hz are called infrasonic.
- Sounds above 20,000 Hz are called ultrasonic.
  - Used for medical imaging and echolocation

8

Doppler Effect

- Frequency shift that is the result of relative motion between the source of waves and an observer.
- Occurs with all wave motion
- Frequency gradually increases as the source approaches, then suddenly drops to a lower pitch as the source passes and moves away.



9

Doppler Effect

- Here's why

- The source of the sound actually catches up to its own sound waves

•**Example**

10