Sound Pre-Quiz

On Your Paper – True or False

1

- We can hear because we concentrate on the source of the sound.

2

- **Loud sound is not dangerous, as long as you don't feel any pain in your ears.**

3

- **High pitched sounds are louder.**

4

- Sound moves faster in air than in solids

5

- In wind instruments, the instrument itself vibrates to transfer the sound.

6

- If I pluck a guitar string, the pitch will change as it slows down (loses energy)

7

- **Sound waves are longitudinal waves.**

8

- As the teacher talks, students hear the voice because particles of air move from the mouth of the teacher to the ear of the student.

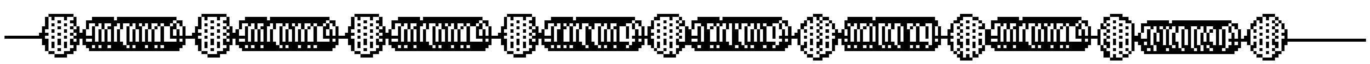
9

- **Sound waves are always caused by a vibrating source.**

10

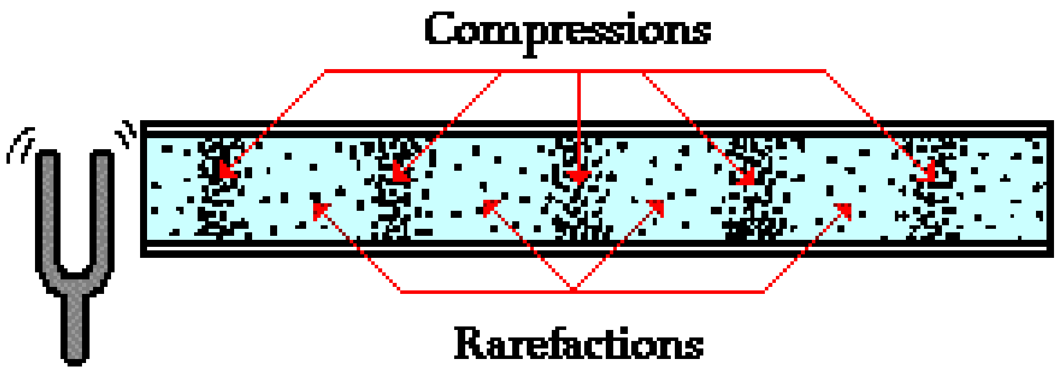
- **How high or low a musical note is depends on its frequency.**

Sound as a Mechanical Wave

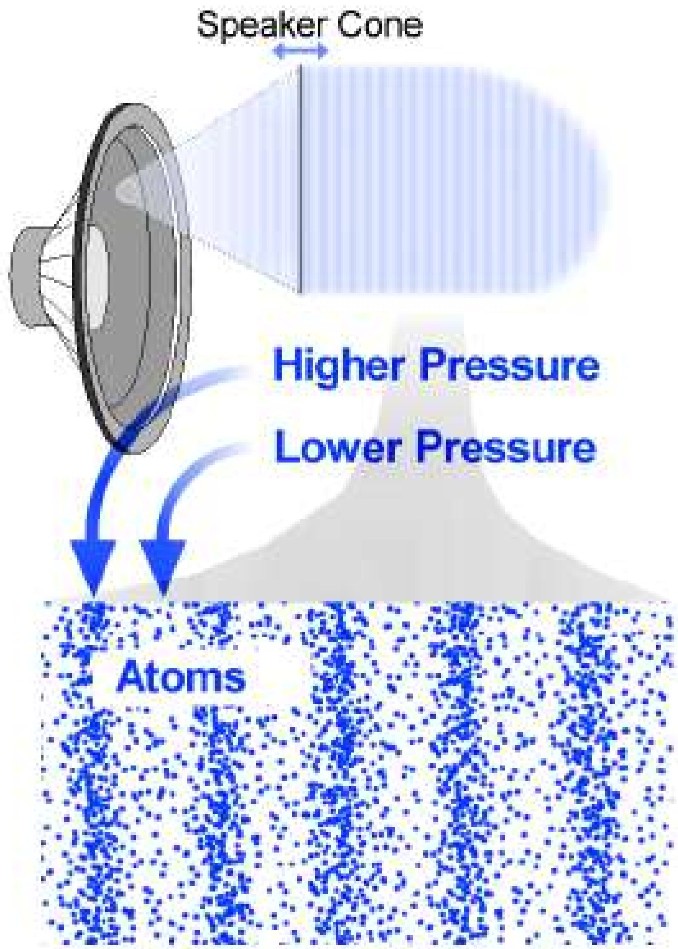


- **Ways sound waves are like this slinky:**
  - medium that carries the disturbance from one location to another
  - an original source of the wave, some vibrating object
  - sound wave is transported from one location to another by means of particle-to-particle interaction
- **Since a sound wave has all of these properties, a sound wave is characterized as a mechanical wave.**

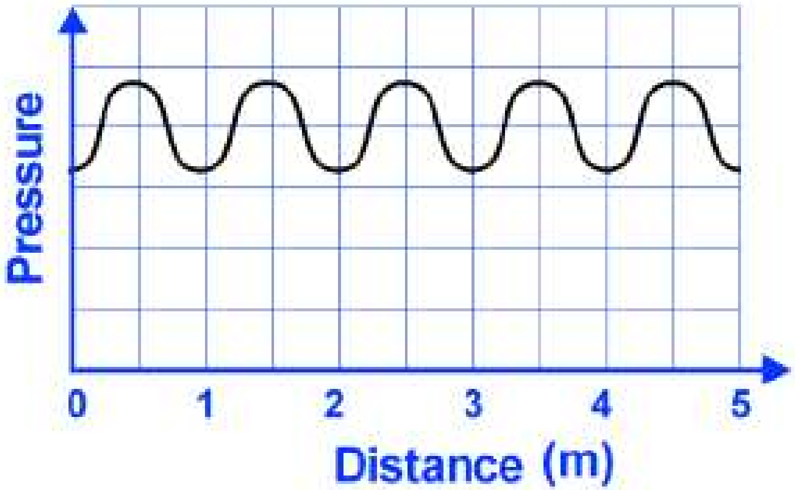
These Terms Still Apply



15.1 Properties of Sound

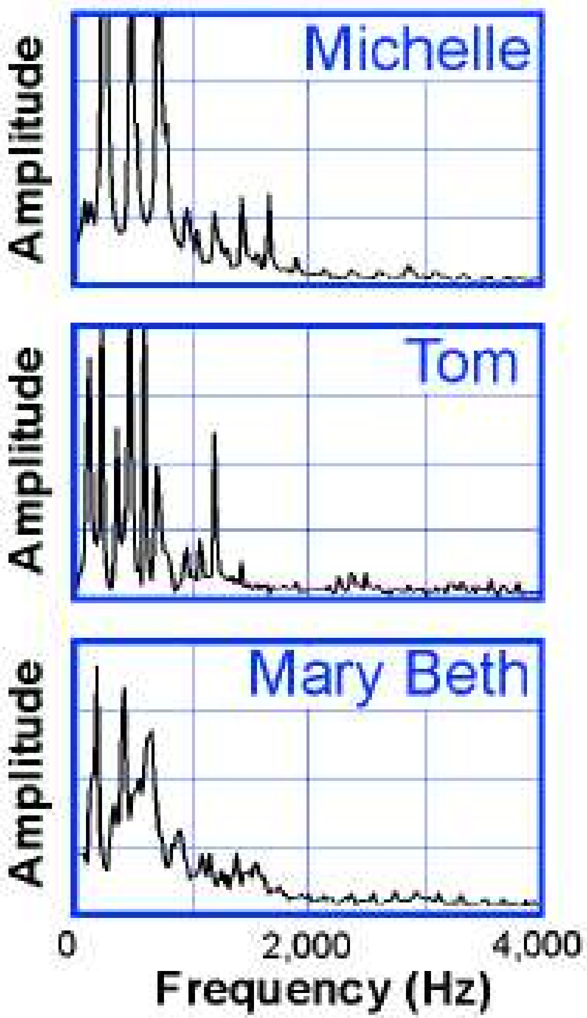


- If you could see the atoms, the difference between high and low pressure is not as great. Here, it is exaggerated.



15.2 The frequency of sound

- We hear frequencies of sound as having different pitch.
- A low frequency sound has a low pitch, like the rumble of a big truck.
- A high-frequency sound has a high pitch, like a whistle or siren.
- In speech, women have higher fundamental frequencies than men.
- High frequency means more vibrations hitting the ear.



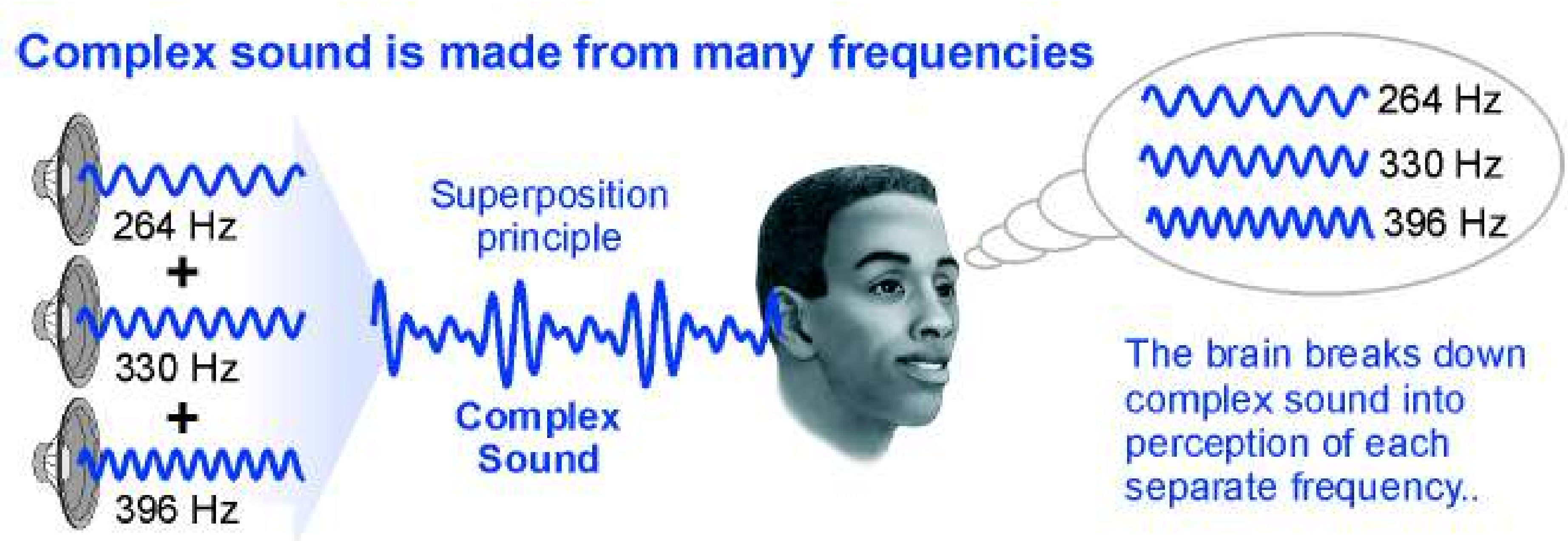
Facts About Pitch

- Pitch is how high or how low a sound seems to be.
- Healthy humans can hear from 20 Hz to 20,000 Hz
- We are most sensitive from 440 Hz to 7,000 Hz.
- Amazingly, many people, especially those who have been musically trained, are capable of detecting a difference in frequency between two separate sounds that is as little as 2 Hz

More Facts

- **Ultrasonic sound has a frequency greater than 20,000 Hz.**
  - Dogs (up to 35,000 Hz)
  - Bats (over 100,000 Hz)
- **Infrasonic sound has a frequency below 20 Hz; they are felt rather than heard**
  - **earthquakes, heavy machinery**

15.1 Complex sound



Music Scales

- **Two sounds with a frequency difference of greater than 7 Hz are played simultaneously**
- **Most people can detect the presence of a complex wave pattern resulting from the interference and superposition of the two sound waves.**
- **Certain sound waves when played (and heard) simultaneously will produce a particularly pleasant sensation when heard, are said to be consonant.**

Music Scales, cont.

- **Examples of other sound wave intervals and their respective frequency ratios are listed in the table below.**

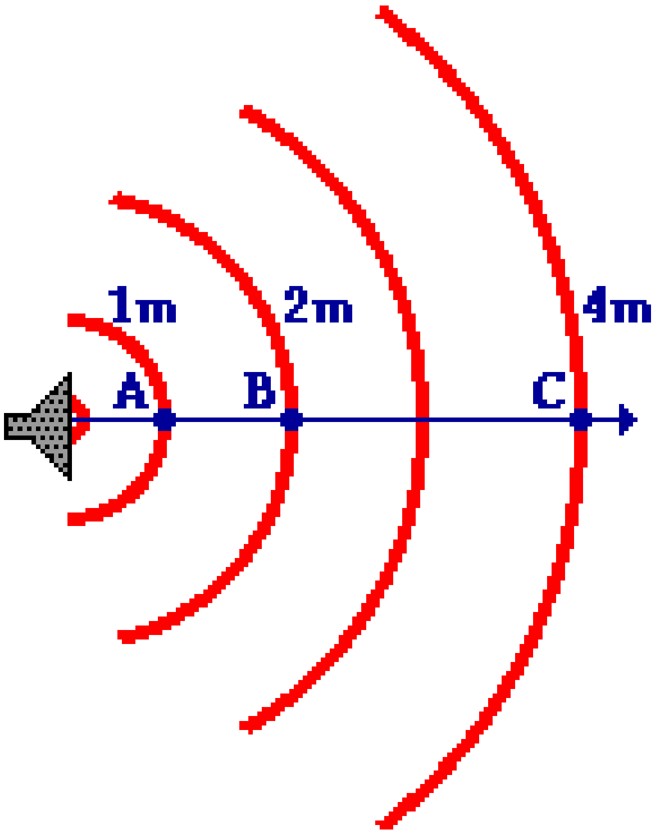
Interval	Frequency Ratio	Examples
Octave	2:1	512 Hz and 256 Hz
Third	5:4	320 Hz and 256 Hz
Fourth	4:3	342 Hz and 256 Hz
Fifth	3:2	384 Hz and 256 Hz

Intensity

- **Intensity depends on the energy in a sound wave.**
- **Intensity - Amount of energy that is transported past a given area of the medium per unit of time.**
  - Intensity is like the "power" of the wave.
- **Greater amplitude = greater rate of energy transfer = greater intensity**

Intensity is affected by distance

Distance	Intensity
1 m	160 units
2 m	40 units
3 m	17.8 units
4 m	10 units



Loudness

- **Loudness is human perception of intensity.**
  - Loudness is measured on the decibel scale.
- **Humans have very sensitive ears; can hear sounds of extremely low intensity.**
- **The faintest sound that the typical human ear can detect has an intensity of $1*10^{-12}$ W/m^2.**
  - **A sound with this intensity is a sound that will displace particles of air by a mere one-billionth of a centimeter.**
  - **The human ear can detect such a sound.**

Decibel Scale

- **Range of intensities that the human ear can detect is so large**
- **Scale used by physicists to measure intensity is a scale based on multiples of 10.**
  - A logarithmic scale
- **The scale for measuring intensity is the decibel scale.**

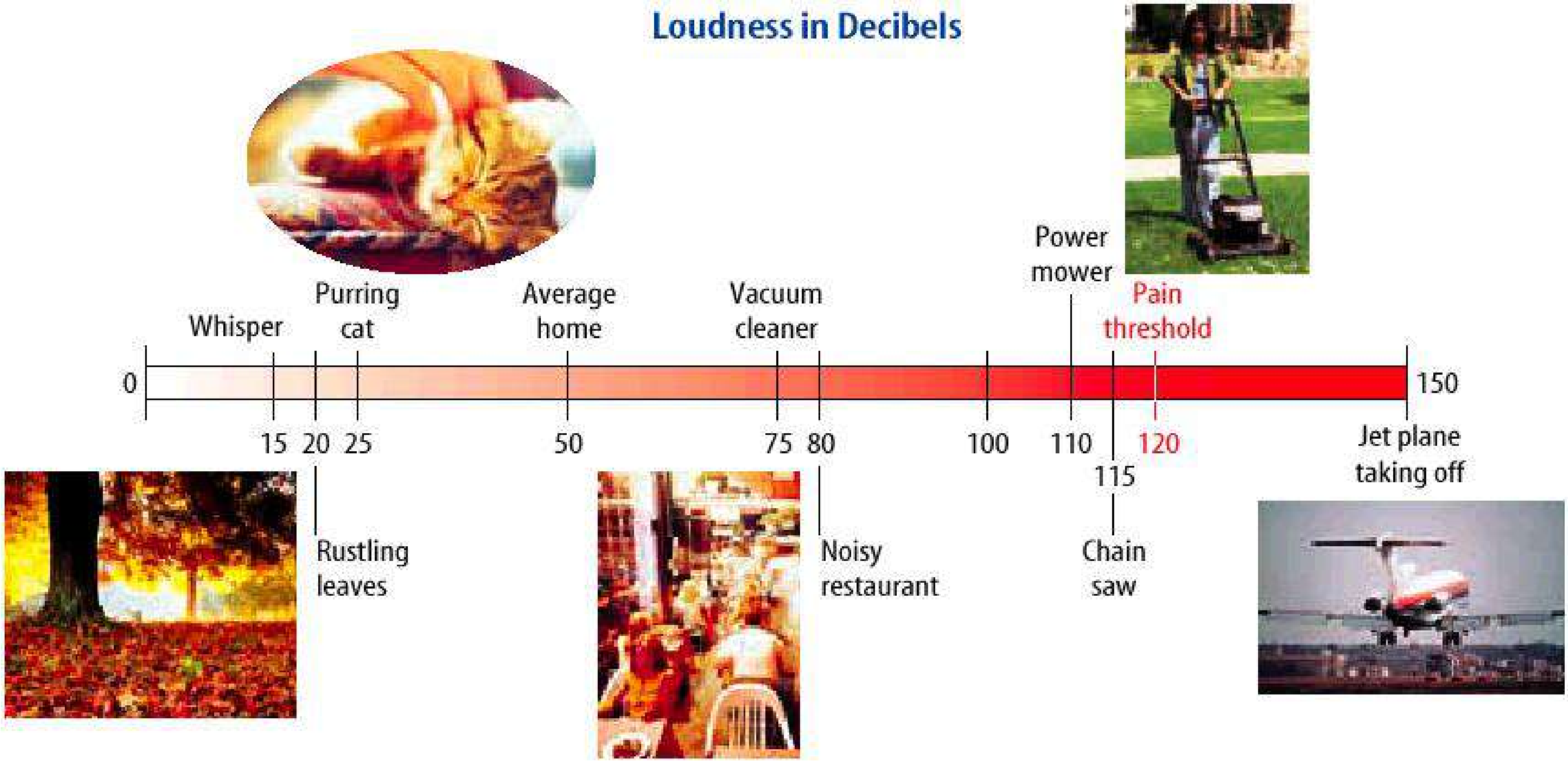
15.1 Loudness

Every increase of 20 dB, means the pressure wave is 10 times greater in amplitude.

Logarithmic scale	Linear scale
Decibels (dB)	Amplitude
0	1
20	10
40	100
60	1,000
80	10,000
100	100,000
120	1,000,000

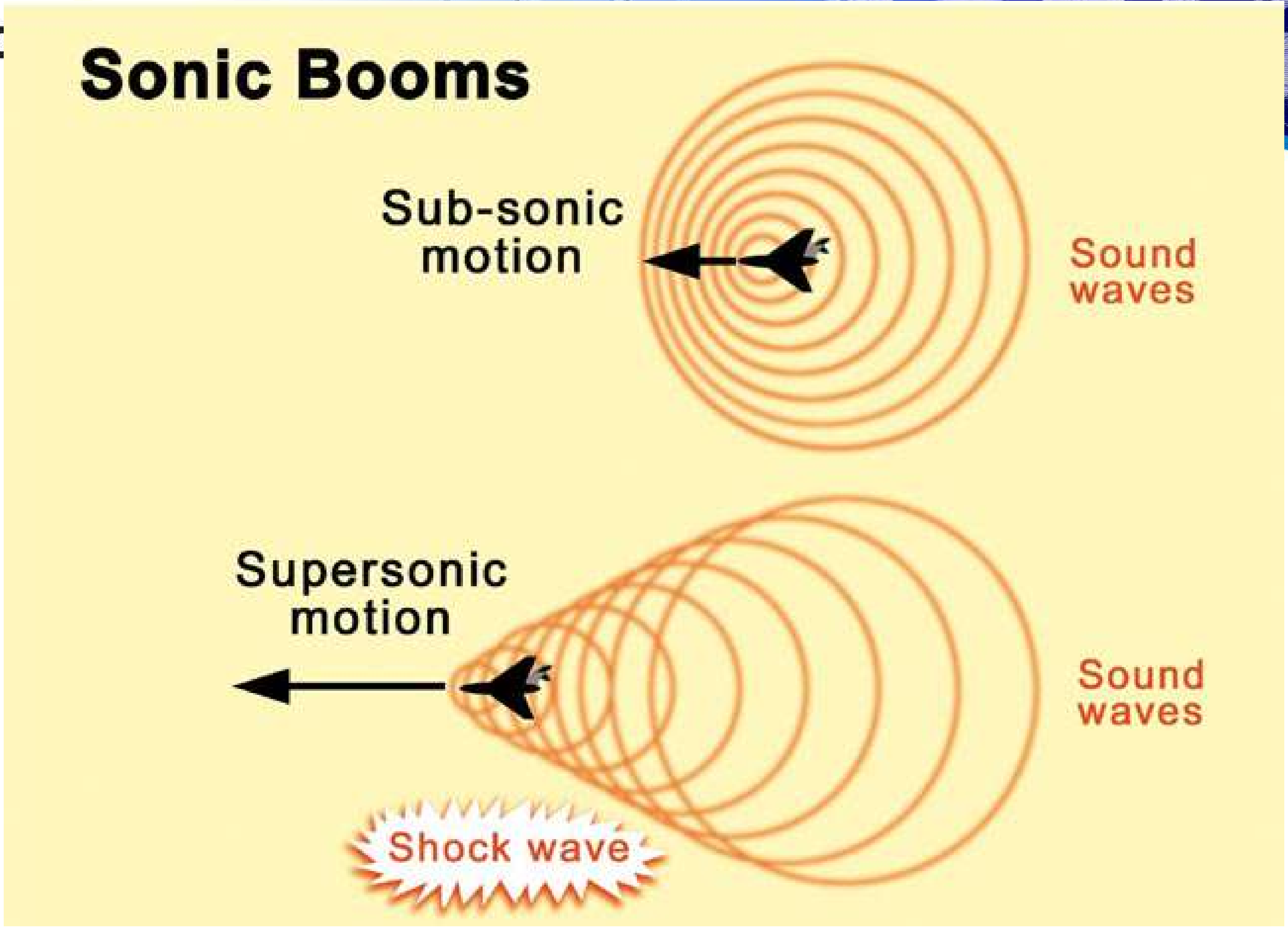
Common Sounds and their Loudness

10 - 15 dB	A quiet whisper, 3 feet away
30 dB	A house in the country
40 dB	A house in the city
45 - 55 dB	The noise level in an average restaurant
65 dB	Ordinary conversation, 3 feet away
70 dB	City traffic
90 dB	A jackhammer cutting up the street, 10 feet away
110 dB	A hammer striking a steel plate 2 feet from your ear. This would be a very loud sound.
120 dB	The threshold of physical pain from loudness



a) Threshold of hearing (0 db)

b) Threshold of pain (120 db)

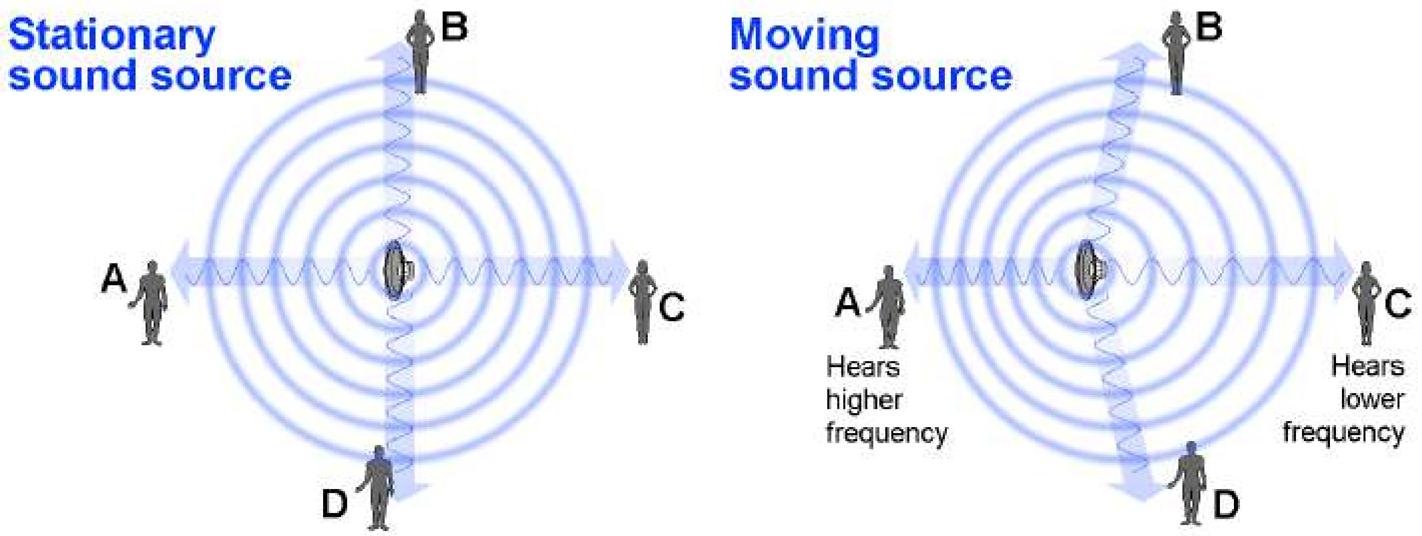

Sonic Booms
Sub-sonic
motion
Sound
waves
Supersonic
motion
Sound
waves
Shock wave

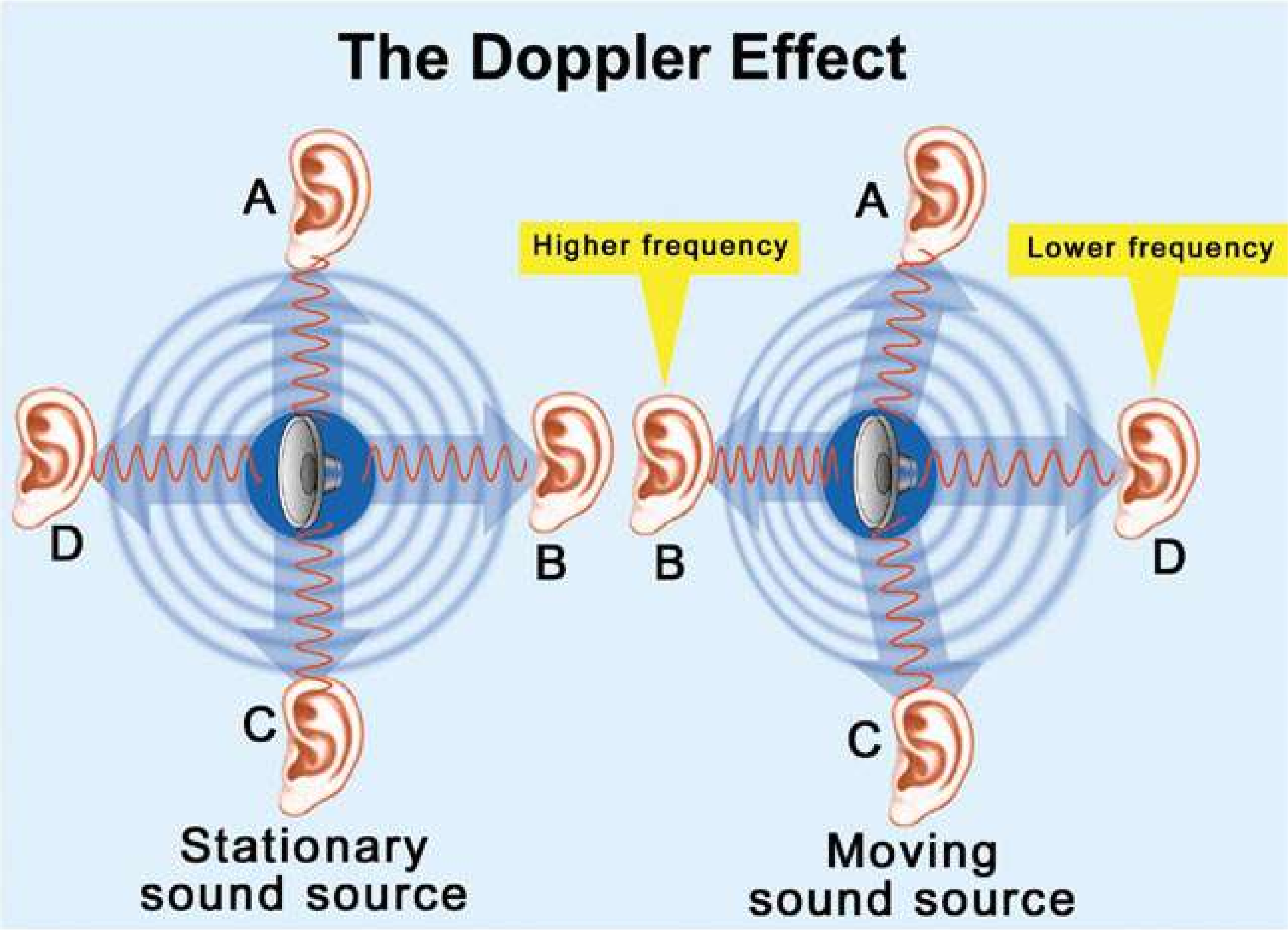
15.2 The wavelength of sound

Frequency (Hz)	Wavelength	Typical Source
20	17 meters	rumble of thunder
100	3.4 meters	bass guitar
500	70 cm (27”)	average male voice
1,000	34 cm (13”)	female soprano singer
2,000	17 cm (6.7”)	fire truck siren
5,000	7 cm (2.7”)	highest note on a piano
10,000	3.4 cm (1.3”)	whine of a jet turbine
20,000	1.7 cm (2/3”)	highest pitched sound you can hear

15.2 The Doppler effect

- The shift in frequency caused by motion is called the **Doppler effect**.
- It occurs when a sound source is moving at speeds less than the speed of sound.




The Doppler Effect
A
Higher frequency
A
Lower frequency
D
B
B
D
C
C
Stationary
sound source
Moving
sound source

Stationary Sound Source

Source Moving Slower than Speed of Sound (Subsonic)

Source Moving Same Speed As Sound (Mach 1)

•

Video

Source Moving Faster than Speed of Sound (Mach 1.4, Supersonic)