Dmitri Shostakovich

(1906-1975)

Symphony No. 5

Last Movement (1937).

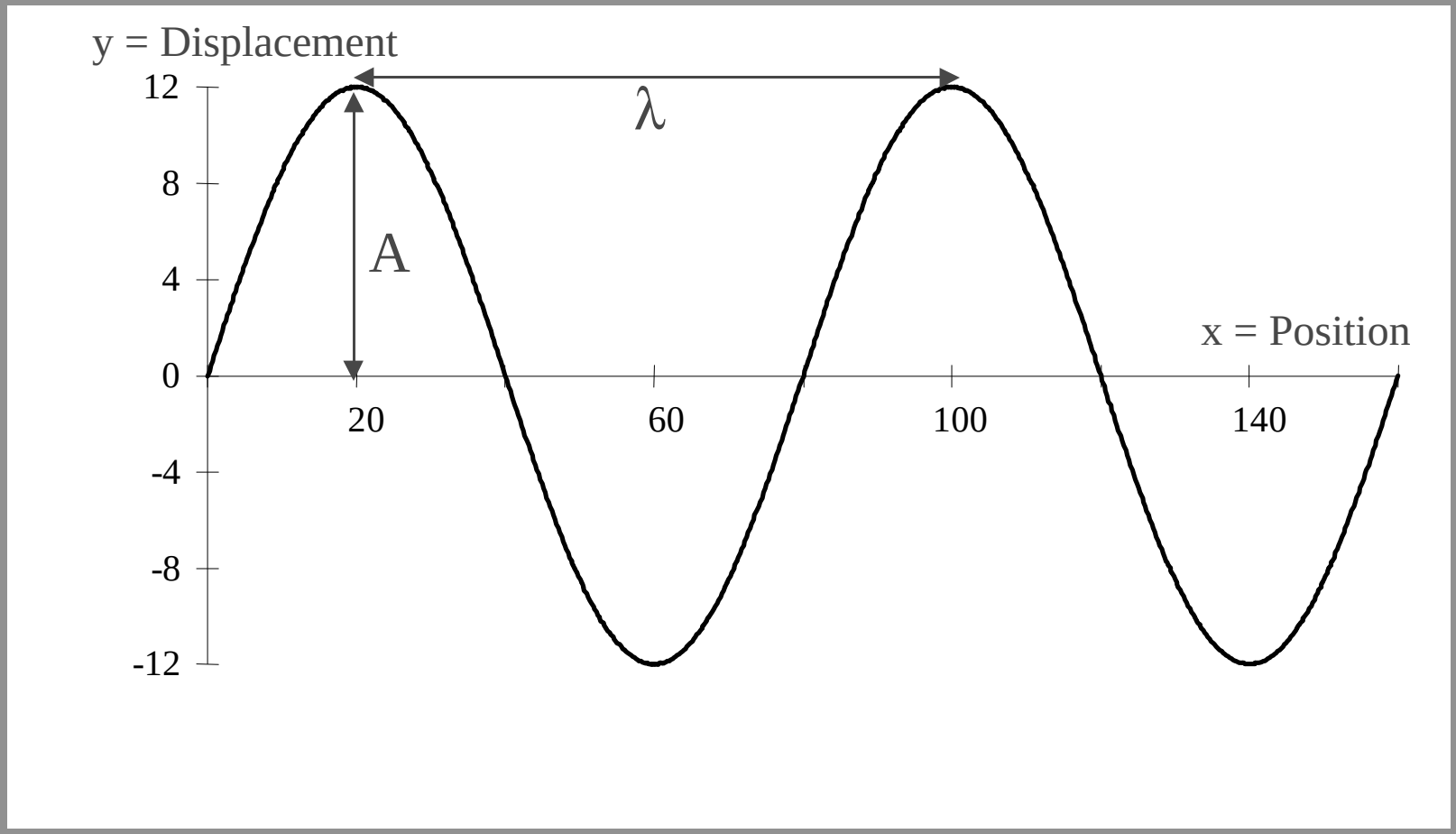
Introduction

Examples of waves

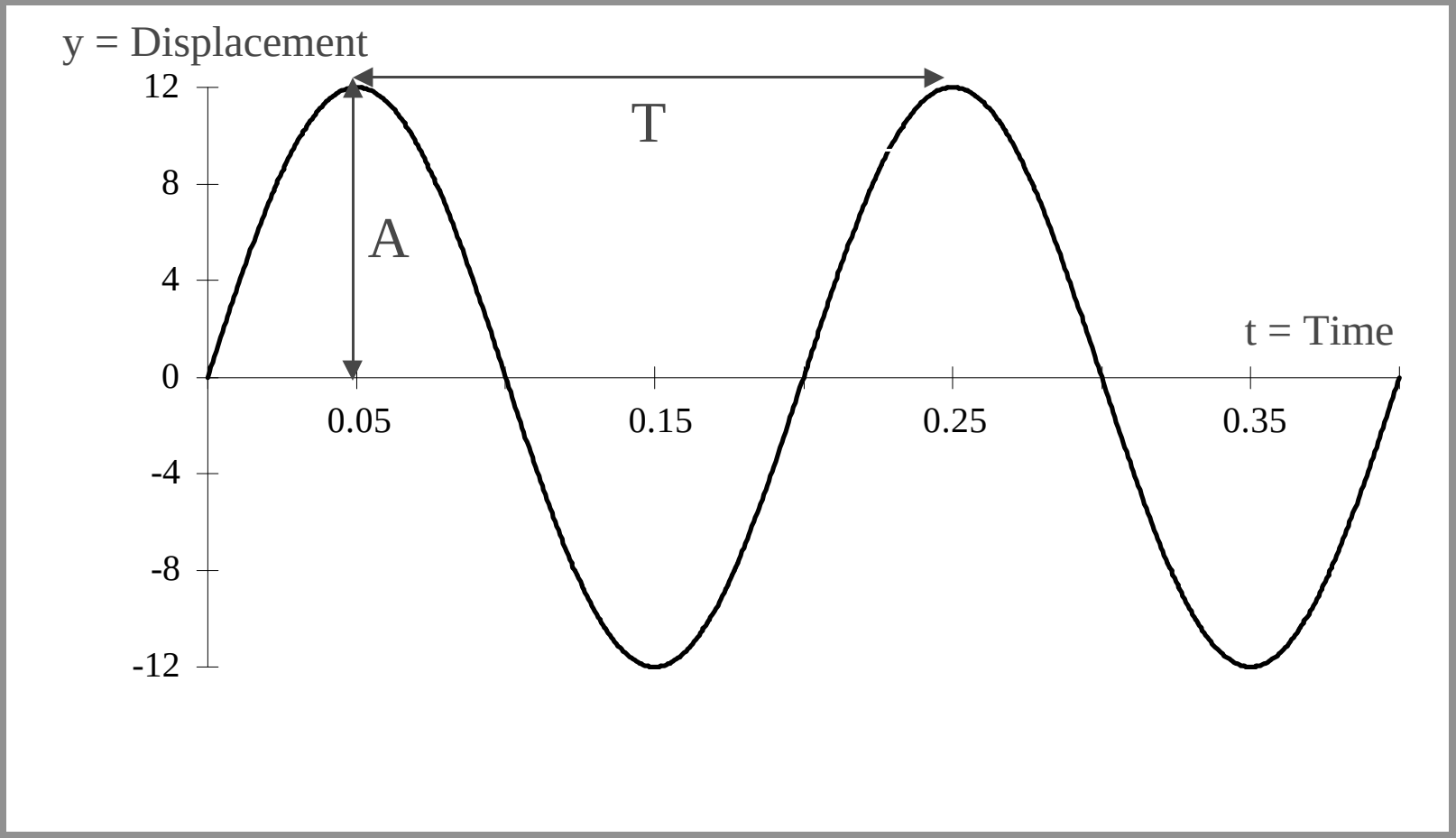
Waves

A wave is an array of neighboring objects oscillating in a regular, progressive manner relative to one another.

Displacement vs. Position

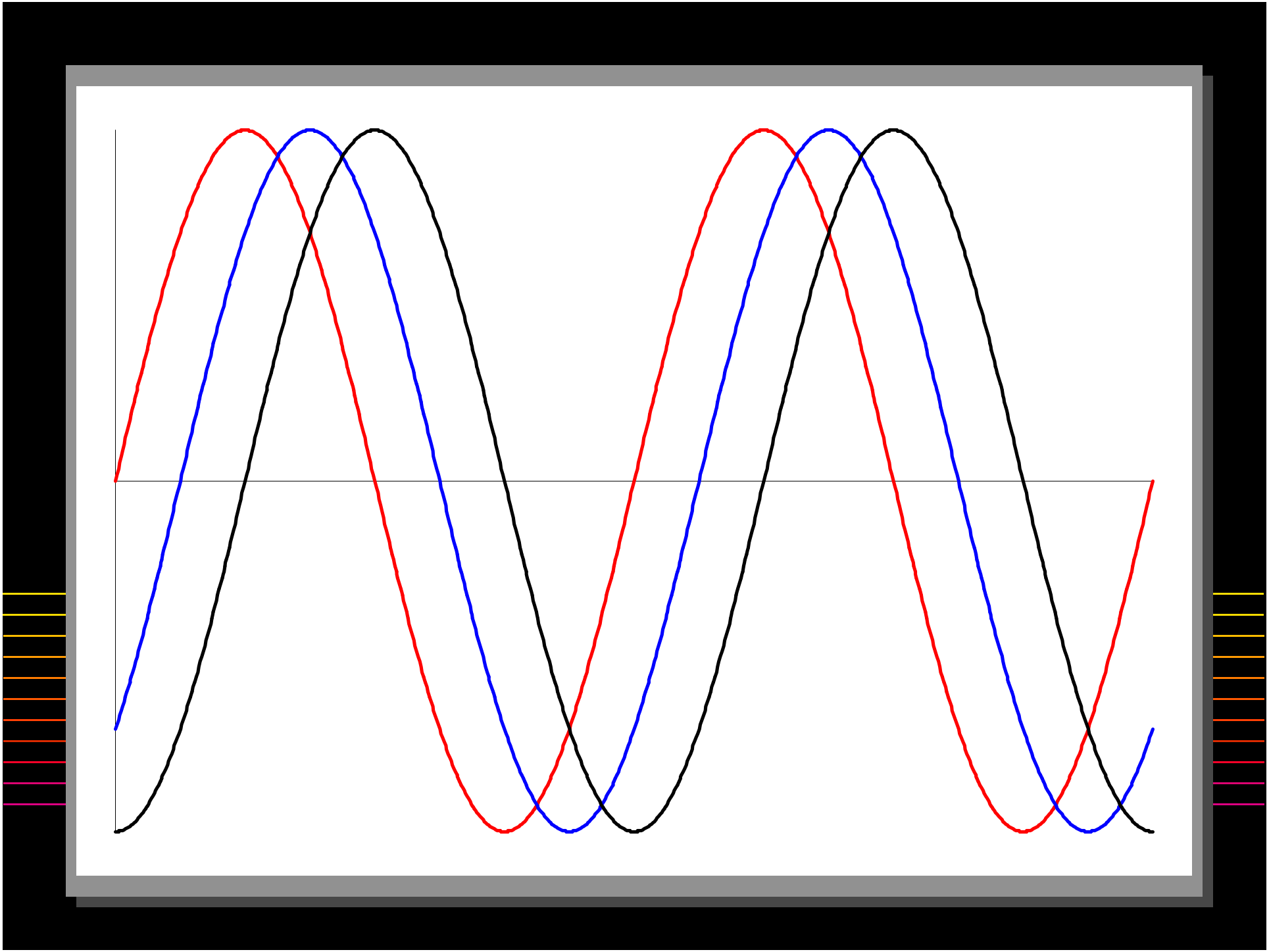


Displacement vs. Time



Terminology

- ***Frequency***
  - Number of oscillations per second
- ***Wavelength***
  - Distance between adjacent crests
- ***Amplitude***
  - Maximum displacement



Types of Waves

- ***Transverse Wave***
  - Particles oscillate perpendicular to the direction in which the wave moves
- ***Longitudinal Wave***
  - Particles oscillate parallel to the direction in which the wave moves

Waves
(Alternate Definition)

- A wave is a disturbance traveling outward from a vibrating source.

Sound Waves

- Produced by oscillating air molecules
- Longitudinal waves
- Periodic pressure variations are set up

Sound Waves

- The actual motion is molecular (microscopic). Difficult to measure and visualize.
- The pressure changes are macroscopic. Easy to measure and visualize.

Sound Waves

- **(1)** When the pulse reaches a particular point, the pressure increases from normal atmospheric pressure to some maximum value.

Sound Waves

- (2) As the pulse continues to move through the point, the pressure begins to return to normal atmospheric pressure.

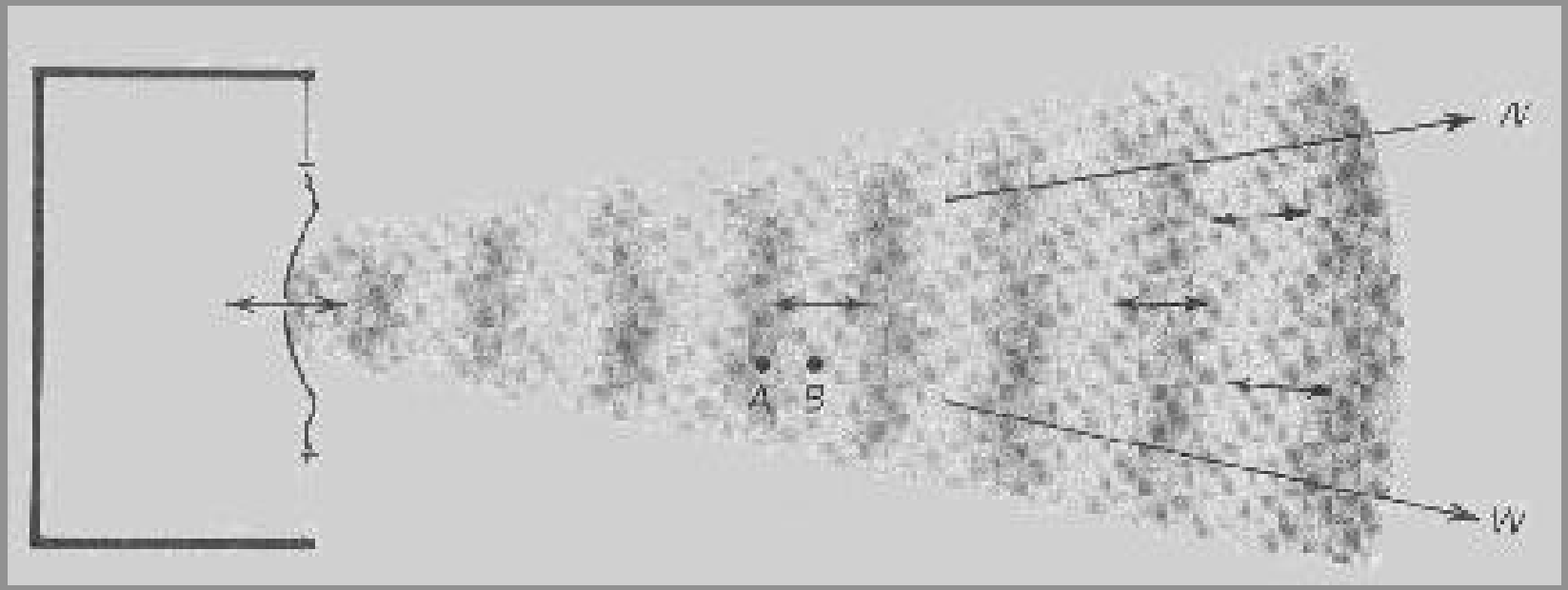
Sound Waves

- **(3)** As the trailing edge of the pulse approaches, the pressure falls below normal atmospheric pressure.

Sound Waves

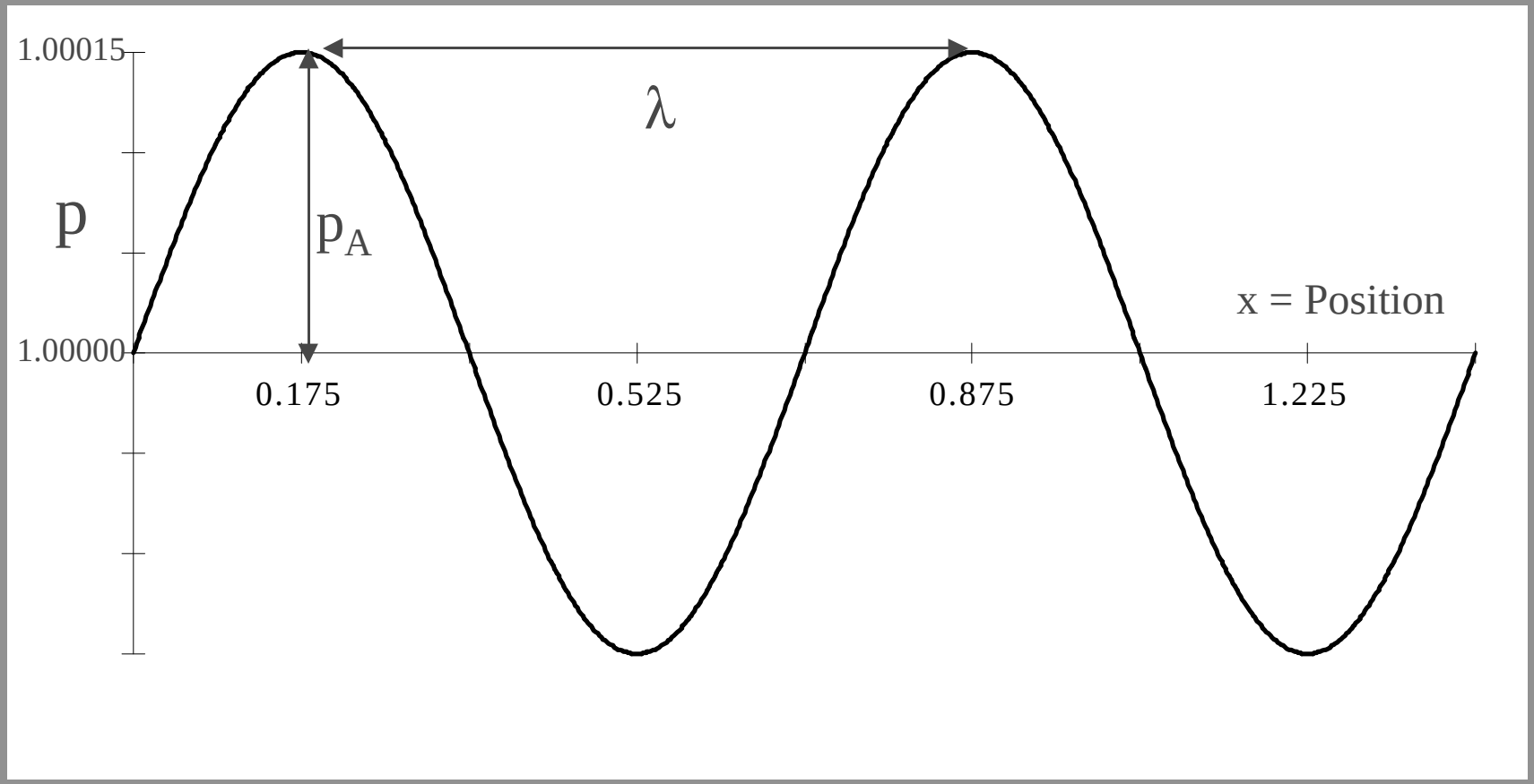
- (4) When the pulse has passed, the pressure returns to normal atmospheric pressure.

Sound Waves
(Pressure Variations)



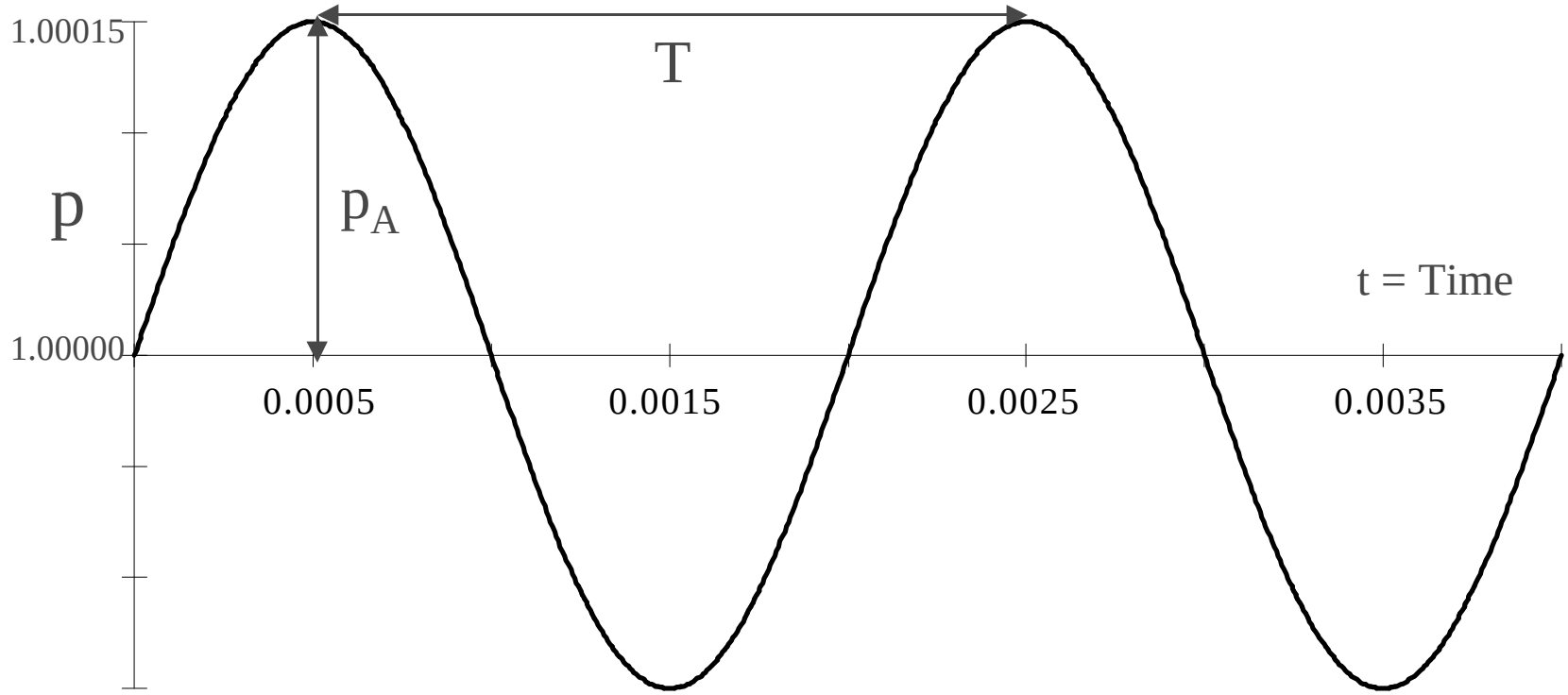
Pressure vs. Position

(at a fixed time)



Pressure vs. Time

(at a fixed point)



Sound Waves

- A sound wave is a longitudinal wave with a frequency between 20 Hz and 20,000 Hz.

Sound Waves

- The frequency of a sound wave is ***always*** the same as the frequency of the vibrating source that produces it.

Sound Waves

- frequencies < 20 Hz
  INFRASOUND
- frequencies > 20,000 Hz
  ULTRASOUND

Velocity of Sound Waves

For Oscillators we found

$$\frac{f_2}{f_1} = \sqrt{\frac{W_1}{W_2}} \qquad \frac{f_2}{f_1} = \sqrt{\frac{k_2}{k_1}}$$

Velocity of Sound Waves

For waves we find similarly

$$\frac{v_2}{v_1} = \sqrt{\frac{W_1}{W_2}} \qquad \frac{v_2}{v_1} = \sqrt{\frac{F_2}{F_1}}$$

W = weight and F = Tension

Velocity of Sound Waves

The velocity of ***any*** wave is ***directly*** proportional to the square root of the stiffness factor and ***inversely*** proportional to the square root of the inertia factor.

Speed of Sound in Air

The speed of sound in air is:

- 344 meters per second
- 1030 feet per second
- 770 miles per hour

Effect of Temperature on Speed of Sound

The speed of sound changes by 0.6 m/s for every 1 degree change in the Celsius temperature.

Effect of Temperature on Speed of Sound

- If the temperature increases, the speed of sound increases.
- If the temperature decreases, the speed of sound decreases.

Energy In Sound Waves

- Kinetic and Potential Energy
- Larger Amplitude means more energy = louder

Relation Among Velocity, Frequency, and Wavelength

$$v = f \lambda$$

Physical/Perceived Musical Characteristics

Physical Characteristic		Perceived Characteristic
Frequency	⟷	Pitch
Amplitude	⟷	Loudness
Waveform	⟷	Timbre