Waves & Interference

I. Definitions and Types

II. Parameters and Equations

III. Sound

IV. Graphs of Waves

V. Interference
- superposition
- standing waves

	The student will be able to:	HW:
1	Define, apply, and give examples of the following concepts: wave, pulse vs. continuous wave, source, medium, longitudinal wave, transverse wave, surface wave, crest, trough, compression, rarefaction. ✓	1 – 11
2	Define, apply and give examples of the following wave parameters: speed, wavelength, frequency, period, and amplitude and state the influence of source and medium on each wave parameter. ✓	
3	Identify the wave type, medium, and speed of mechanical waves and sound. State the relation between speed, wavelength, and frequency for a wave, and use this relation to solve related problems.	12 – 18
4	Solve problems analyzing graphs to determine a wave's parameters.	19 – 21
5	Define and apply the following concepts: superposition, constructive and destructive interference, phase, beat frequency and solve related problems.	22 – 24
6	Explain the requirements for the creation of a standing wave. Define and identify nodes and antinodes in standing wave patterns. Solve problems involving harmonics for strings or pipes.	25 – 38
7	Define resonance and identify and give examples of this phenomenon.	39 – 41

What *is* Sound?

- Sound is a longitudinal wave traveling through a physical medium.
- Sound can occur in any form of matter: solid, liquid, gas, or plasma. (It cannot exist in a vacuum.)
- The source of a sound wave is a vibrating object that initiates the disturbance.
- The speed of a sound wave is determined by the properties of the medium through which it travels (independent of the source).
- The frequency of a sound wave always equals the frequency of the source (independent of the medium).

The Speed of Sound

- In air at 0 ºC, v = 331 m/s (740 mph).
- The speed increases at higher temperatures by about 0.6 m/s per degree.
- In air at 20 ºC, v = 343 m/s (767 mph). This is at "room temperature" 68 ºF. Unless stated otherwise use this value!
- Speed of sound is much different through solids and liquids…

Speed of Sound	
Air (20 °C)	343 m/s
Water	1480 m/s
Sea Water	1520 m/s
Steel	5000 m/s

Transition of Medium

- When sound (or any wave for that matter) undergoes a change in medium, its speed will undergo a corresponding change.
- However, the frequency will not change. Frequency is determined by the source of the wave and unaffected by the medium.
- Because frequency remains constant the wavelength must change with the speed – if speed increases wavelength must also increase so that $v = f\lambda$.

Human Hearing

- Pitch is the "highness" or "lowness" of a tone in the musical sense – i.e. a high note or a low note.
- Pitch is determined by and correlates with frequency – higher frequency is higher pitch or higher note.
- A normal person can hear only frequencies of sound between 20 Hz and 20 kHz.
- Other sounds can exist, but are undetectable by humans. Sound below 20 Hz is called subsonic and above 20 kHz is called ultrasound.

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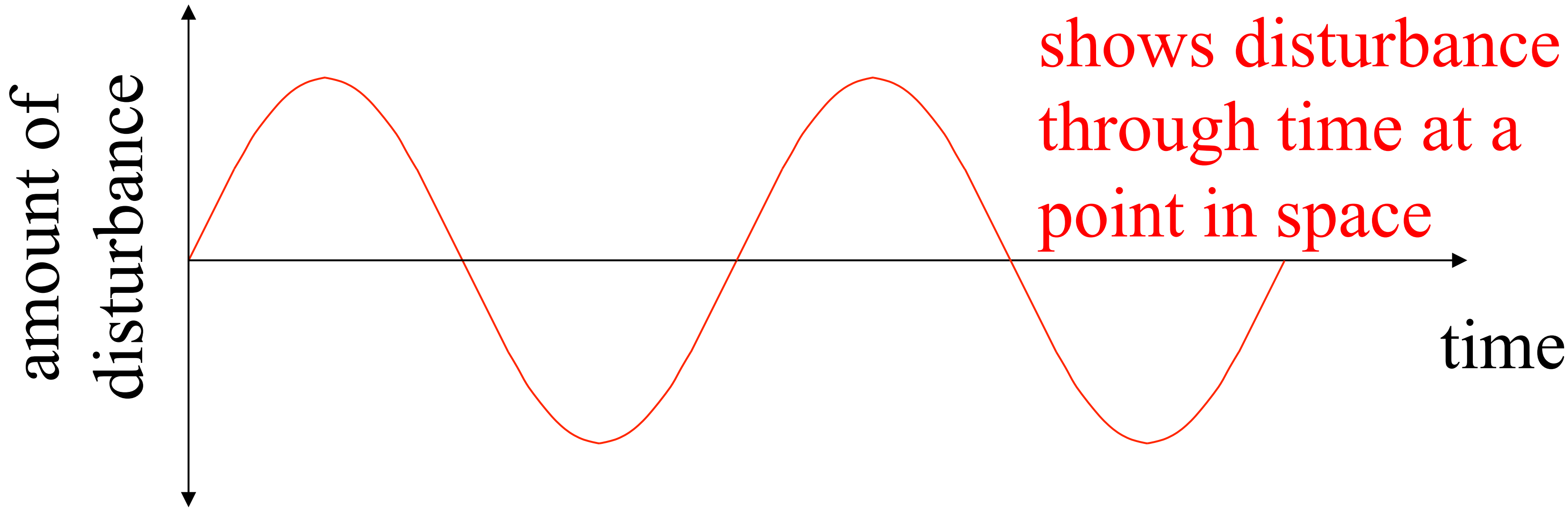
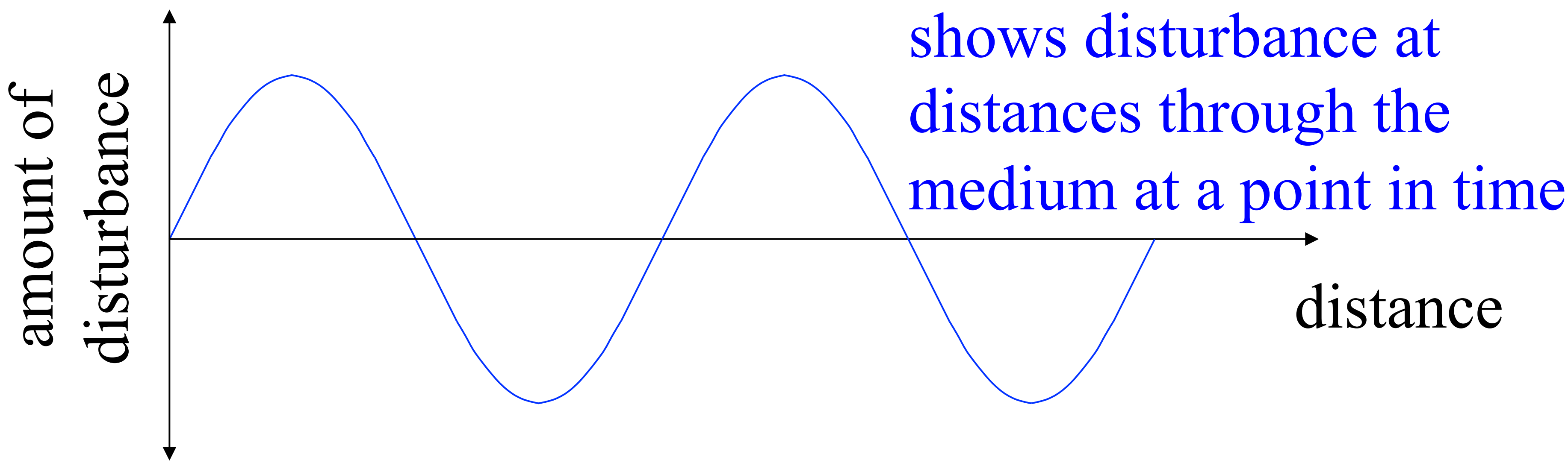
Wave Graphs

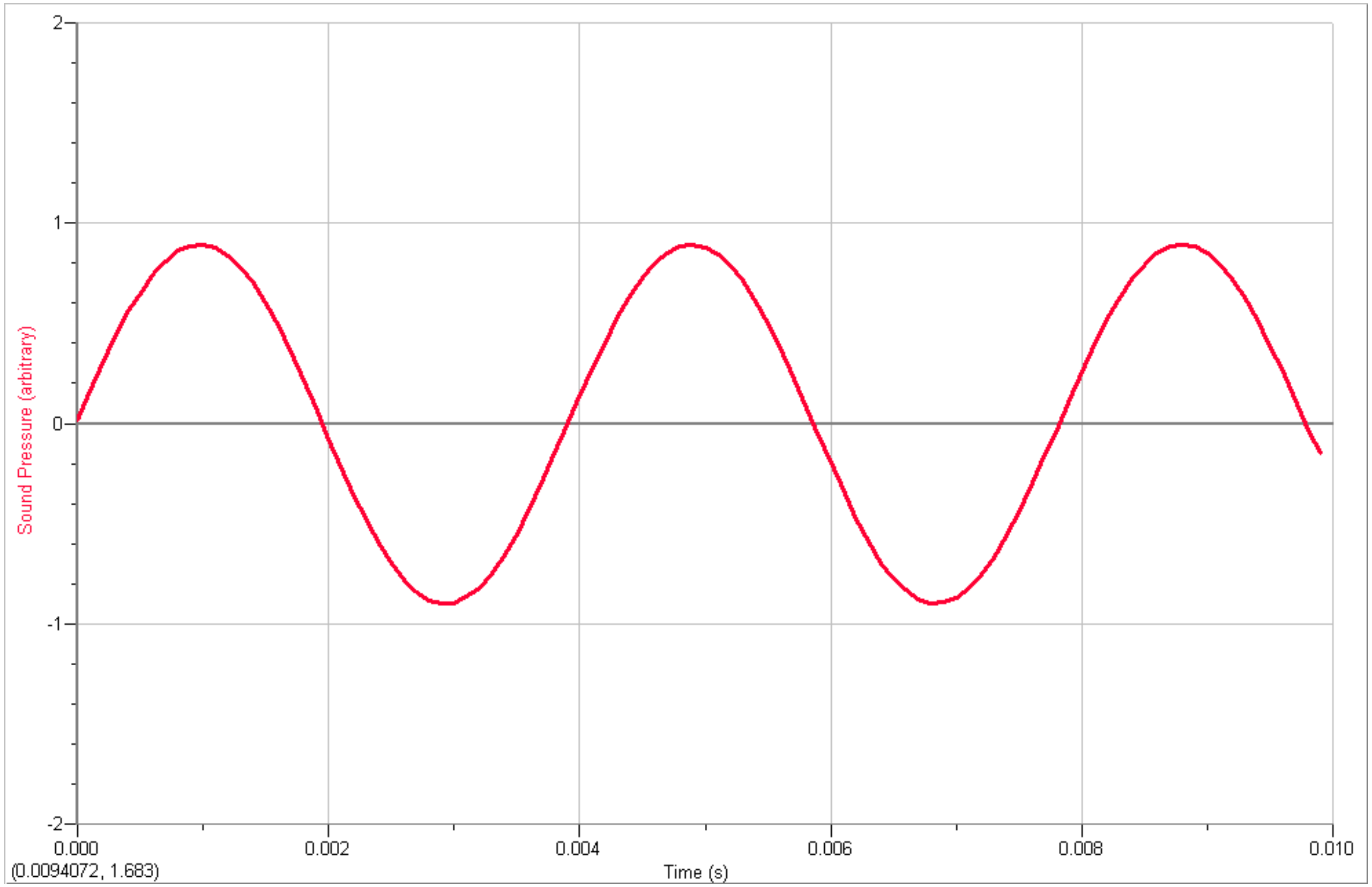
- Aside from wavelength, frequency, speed, and amplitude a wave can be unique in its shape or form.
- The shape or form of the wave is the pattern of disturbance. A wide variety of patterns and shapes are possible.
- A common type of pattern is a sinusoidal wave (or more simply a "sine wave").
- A sine wave can be initiated by a vibrating object undergoing simple harmonic motion. The particles of the medium in a sine wave undergo simple harmonic motion as well.

Two Types of Wave Graphs



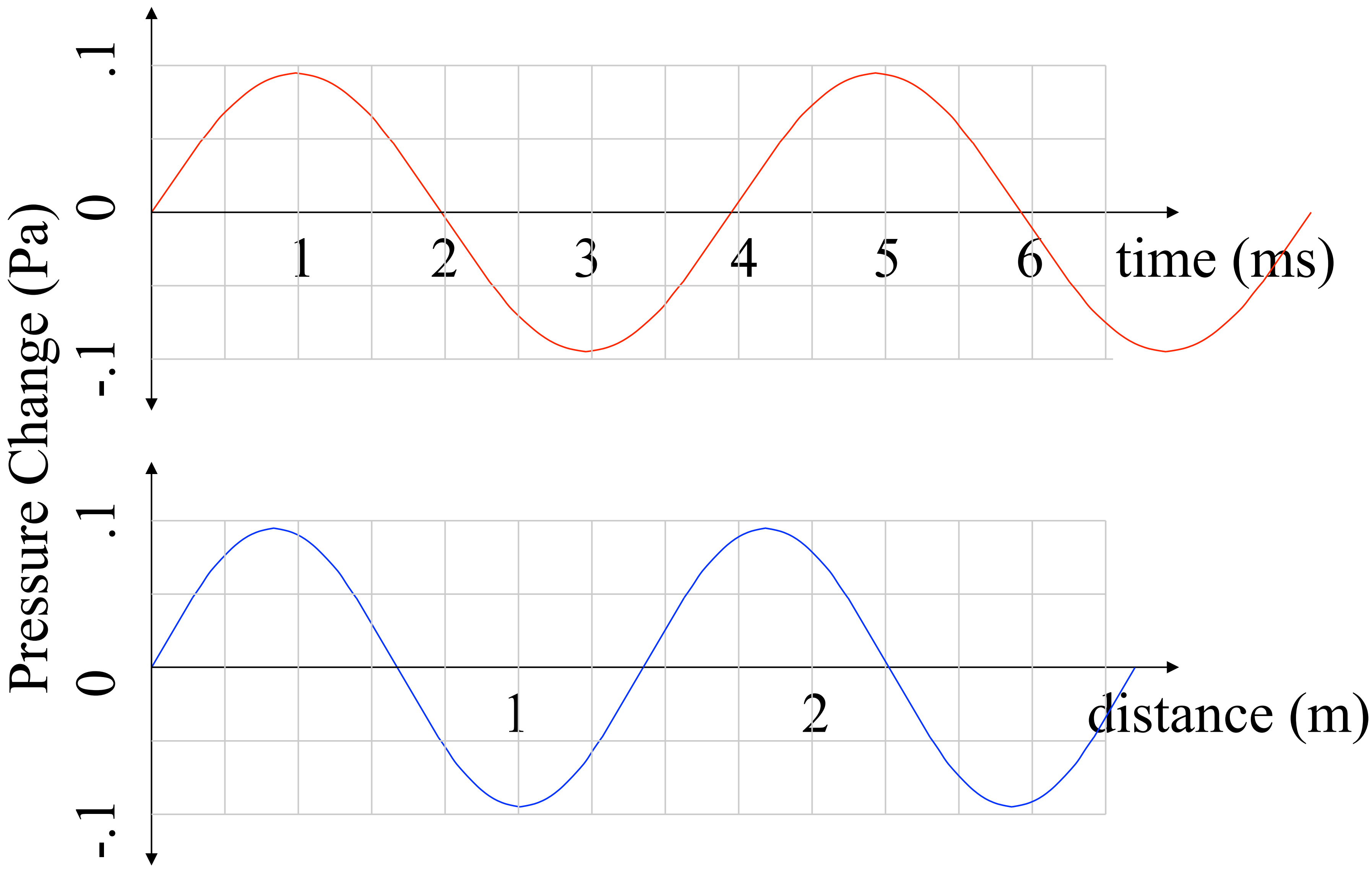


Graph of Sound Wave Made by Tuning Fork:

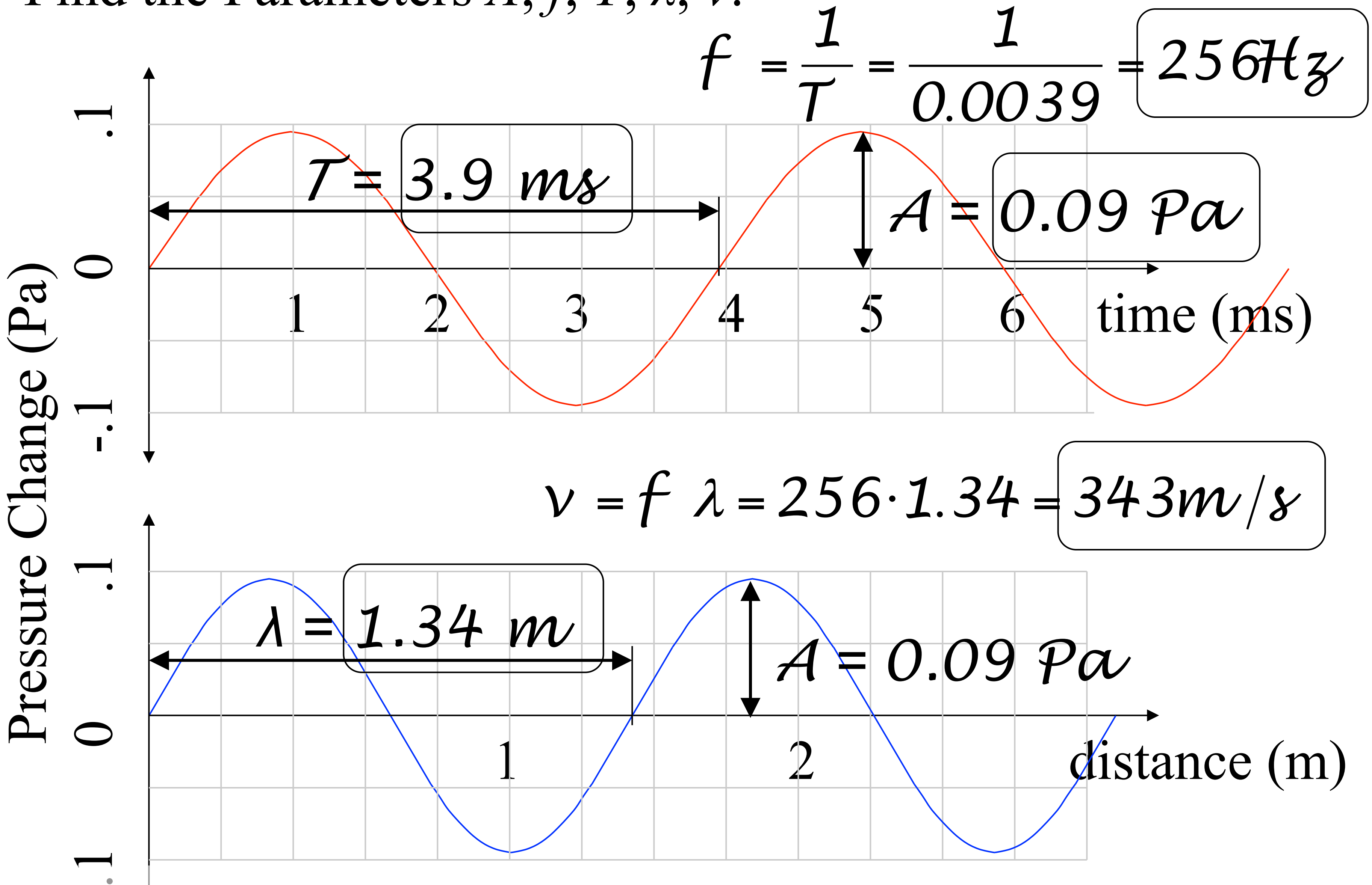


This is the output of an **oscilloscope**. An oscilloscope displays voltage vs. time – in this case the voltage output of a microphone.

Example – Find the Parameters *A*, *f*, *T*, *λ*, *v*



Find the Parameters A, f, T, λ, v:



This illustrates properties of a sound made by a tuning fork producing a sinusoidal pure tone near middle C on the piano.