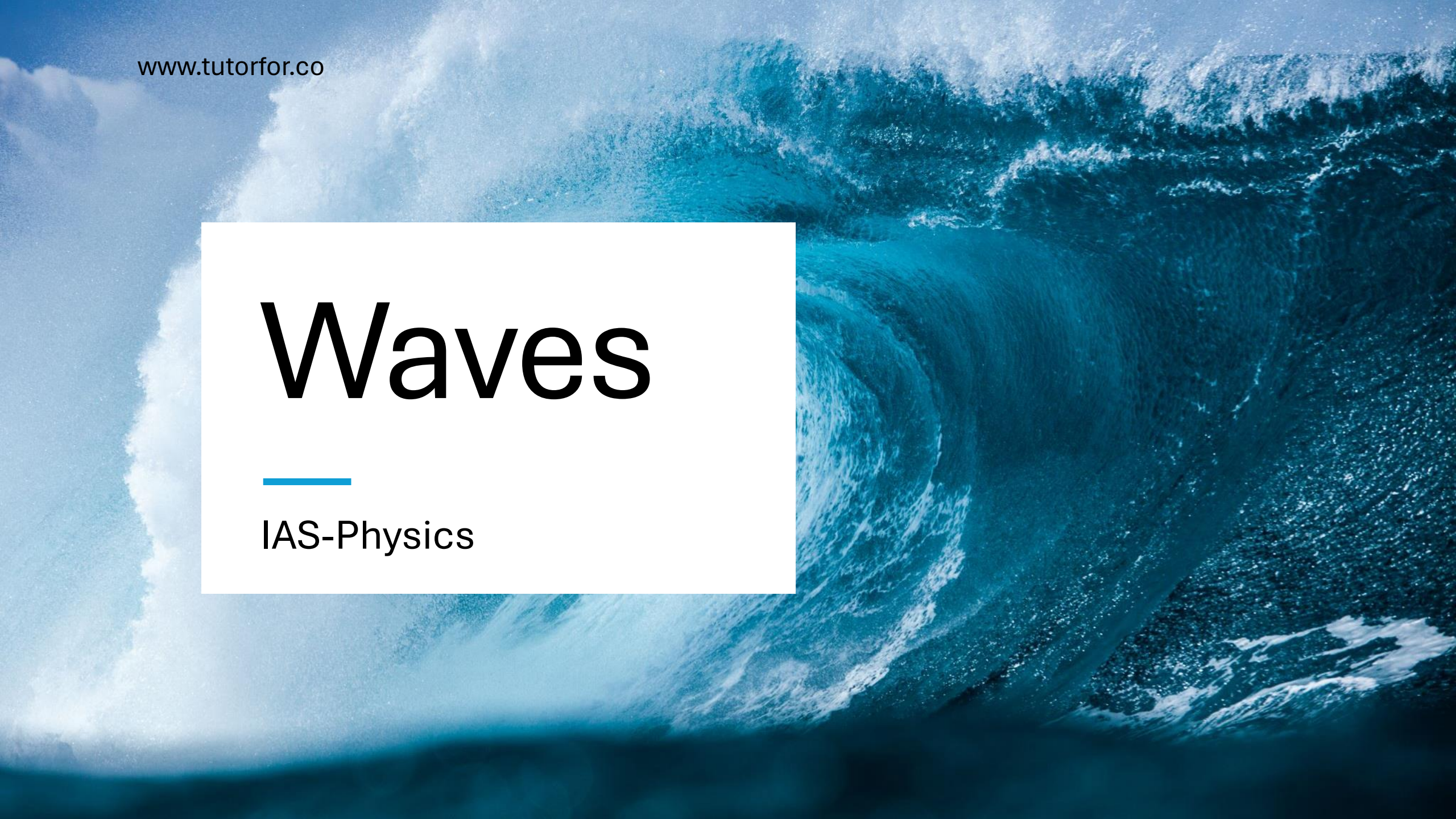


Waves

IAS-Physics

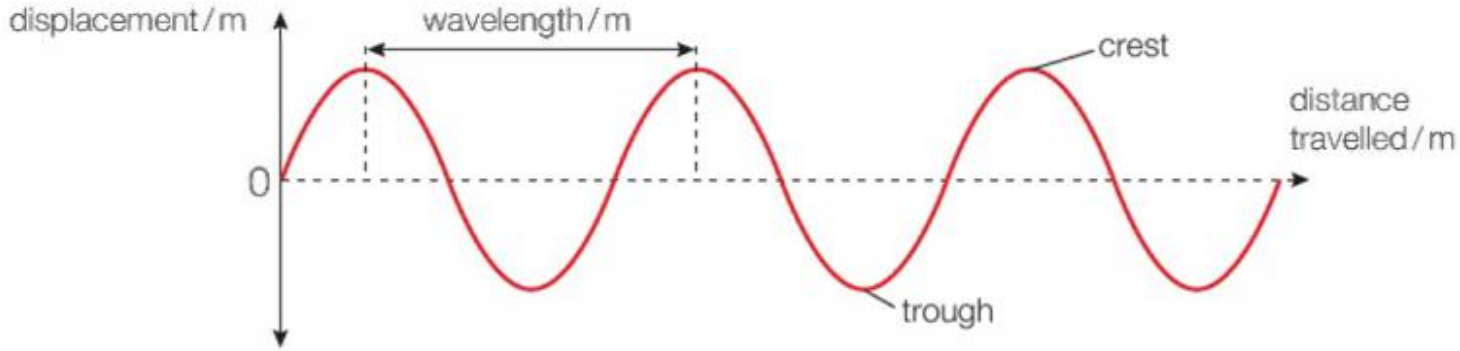
Objectives

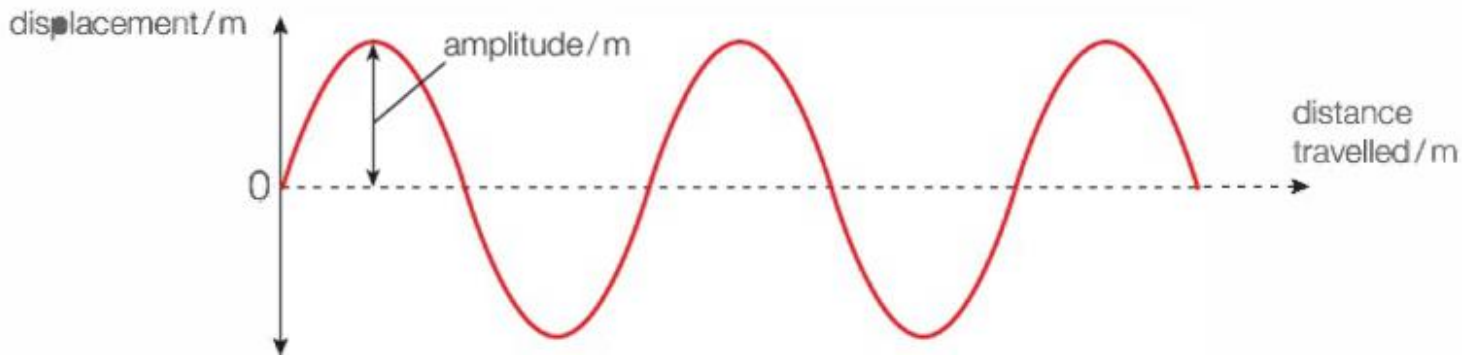
33	understand the terms amplitude, frequency, period, speed and wavelength
34	be able to use the wave equation $v = f\lambda$
35	be able to describe longitudinal waves in terms of pressure variation and the displacement of molecules
36	be able to describe transverse waves
37	be able to draw and interpret graphs representing transverse and longitudinal waves including standing/stationary waves
38	**CORE PRACTICAL 4: Determine the speed of sound in air using a 2-beam oscilloscope, signal generator, speaker and microphone**
39	know and understand what is meant by *wavefront, coherence, path difference, superposition, interference* and *phase*
40	be able to use the relationship between *phase difference* and *path difference*
41	know what is meant by a *standing/stationary* wave and understand how such a wave is formed, know how to identify nodes and antinodes
42	be able to use the equation for the speed of a transverse wave on a string $v = \sqrt{\frac{T}{\mu}}$
43	**CORE PRACTICAL 5: Investigate the effects of length, tension and mass per unit length on the frequency of a vibrating string or wire**

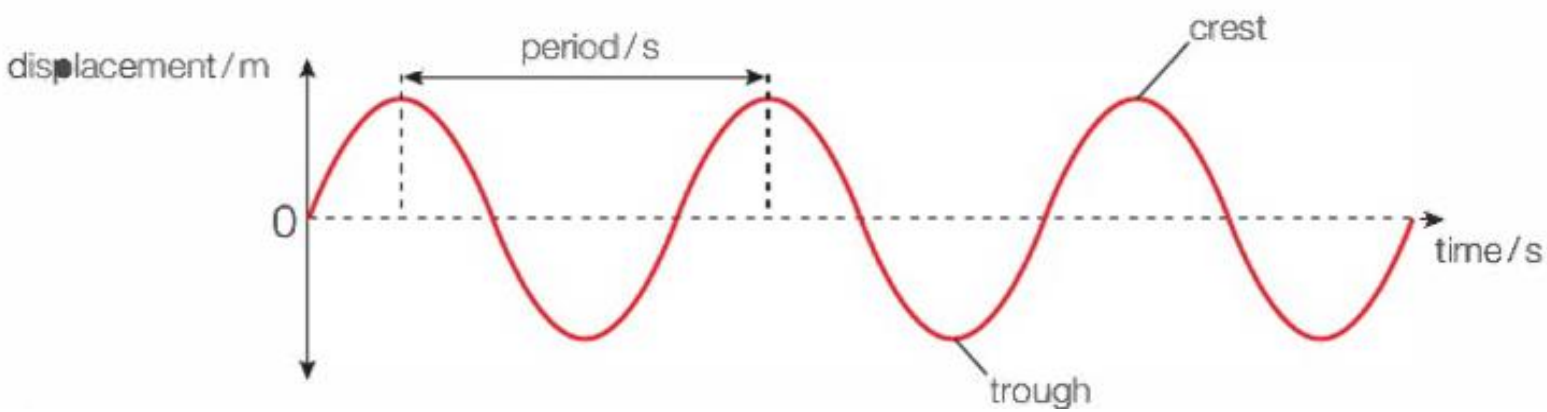
Wave Basics

- A wave is a means for transferring energy via oscillations.
- Whilst energy moves from one place to another; the waves cause no net movement of any matter
- Wavelength(λ)-The distance between a point on a wave and the same point on the next cycle of the wave. SI unit-m.
- Amplitude(A)-The magnitude of the maximum displacement reached by an oscillation in the wave. SI unit-m.
- Period(T)-The time taken fo r one complete oscillation at one point on the wave. SI unit-s.
- Frequency(f) - The number of complete wave cycles per second. SI unit-Hz.

GRAPHING WAVES







Wave speed(v)

- The rate of movement of the wave. SI unit-m/s.

- $wave\ speed = frequency \times wavelength$

$$v = f\lambda$$

Concept Learning Question:

The wavelength of a sound wave is 25 cm and the frequency 1320 Hz. Find the speed of the wave.

Practical : Investigating the speed of sound.

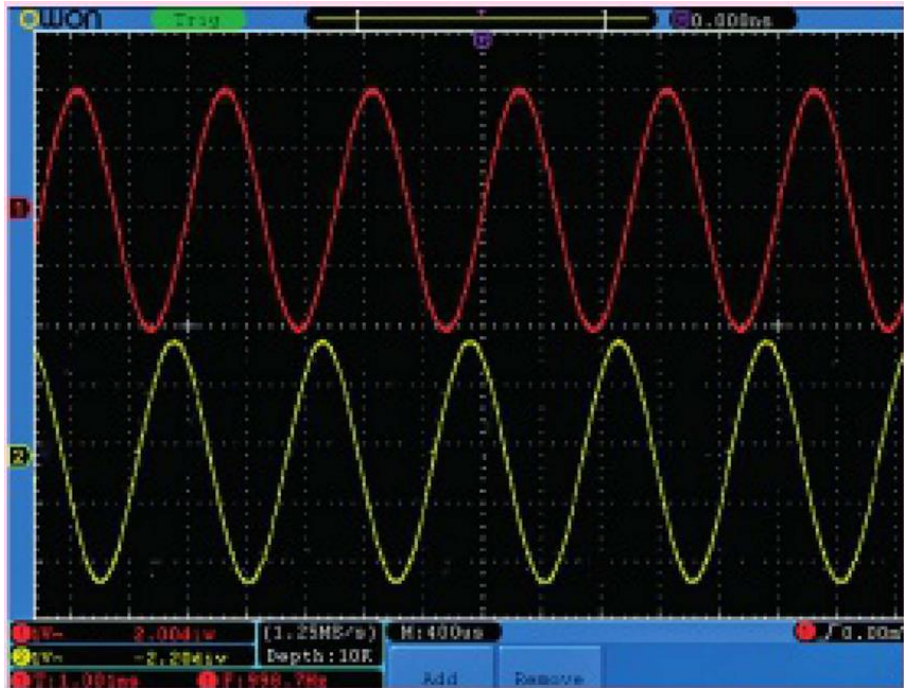
To investigate the speed of sound using a twin-beam oscilloscope, place a loudspeaker and two microphones, with one microphone at a fixed distance (50 cm) from the loudspeaker and the other further away.

Observe the time difference between the sound signals received by the two microphones on the oscilloscope. This time difference, along with the known extra distance, allows calculation of the speed of sound using

$$v = \frac{d}{t}.$$

To improve accuracy, synchronize the oscilloscope traces by starting with both microphones equidistant from the loudspeaker, then moving the second microphone until the traces are back in phase.

The distance between the microphones at this point is one wavelength, λ, allowing the use of the wave equation $v = f\lambda$ to find the speed of sound, given the frequency set on the signal generator.

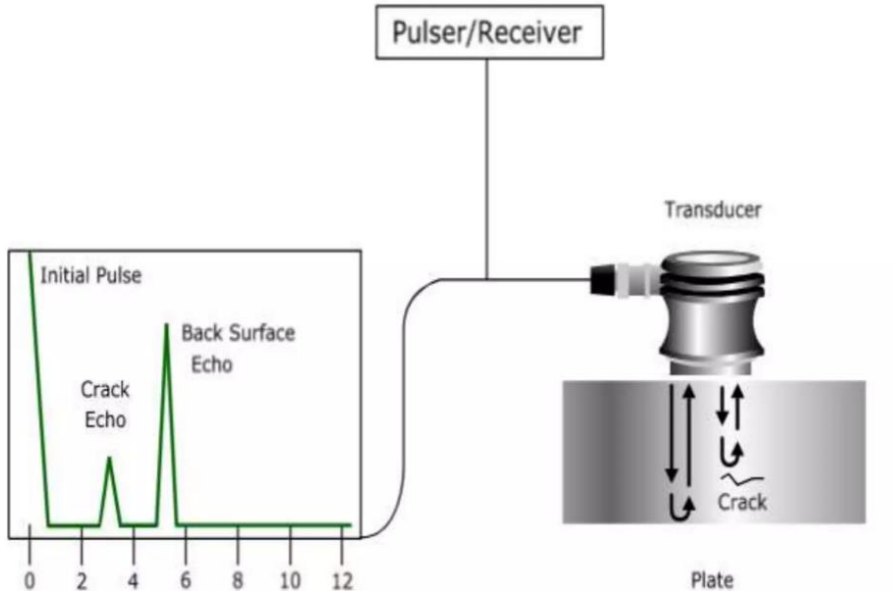


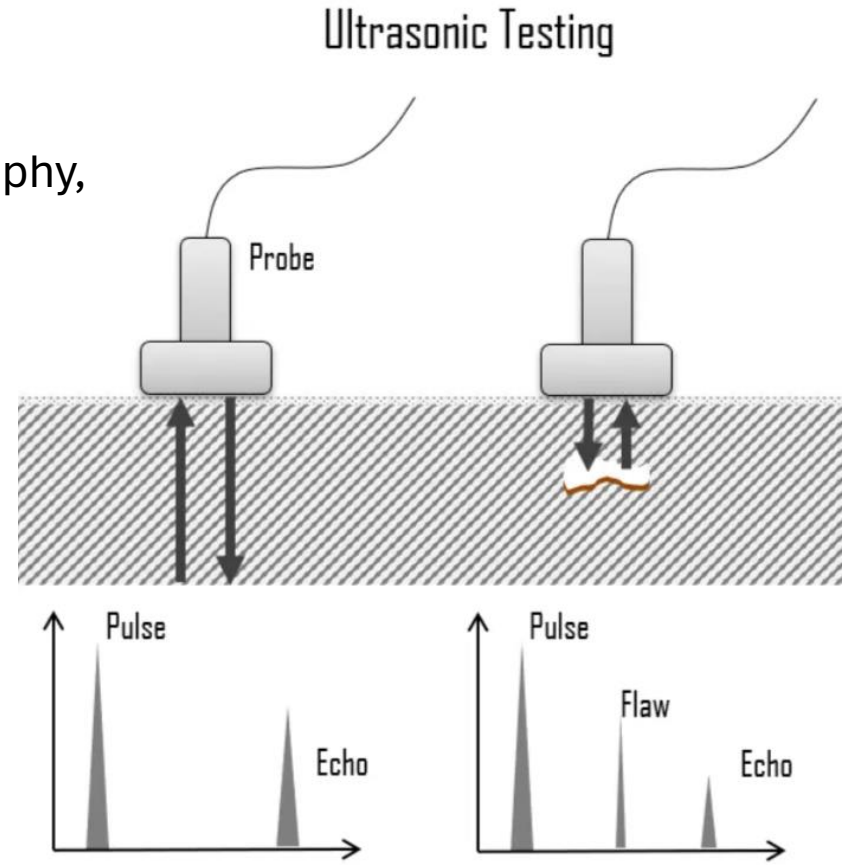
Pulse echo-measurement

Pulse echo measurement is a technique used to determine the distance to an object or the thickness of a material by sending a short burst of ultrasonic sound waves (pulse) into the material.
The sound waves reflect off boundaries or interfaces within the material and return to the transducer (echo). By measuring the time interval between the emission of the pulse and the reception of the echo, and knowing the speed of sound in the material, the distance to the reflecting surface or the thickness of the material can be calculated using the formula

$$\textbf{distance} = \frac{v \times t}{2}$$

where vv is the speed of sound and tt is the round-trip time. This method is widely used in applications such as medical ultrasonography, non-destructive testing, and sonar





Concept Learning Questions.

1) If the time interval between a pulse and its echo is 2 milliseconds and the speed of sound in the material is 1500 m/s, what is the distance to the reflecting surface?

2) During an experiment, you find that moving the second microphone 0.5 meters away brings the oscilloscope traces back in phase. If the frequency of the sound wave is 680 Hz, what is the speed of sound in the medium?