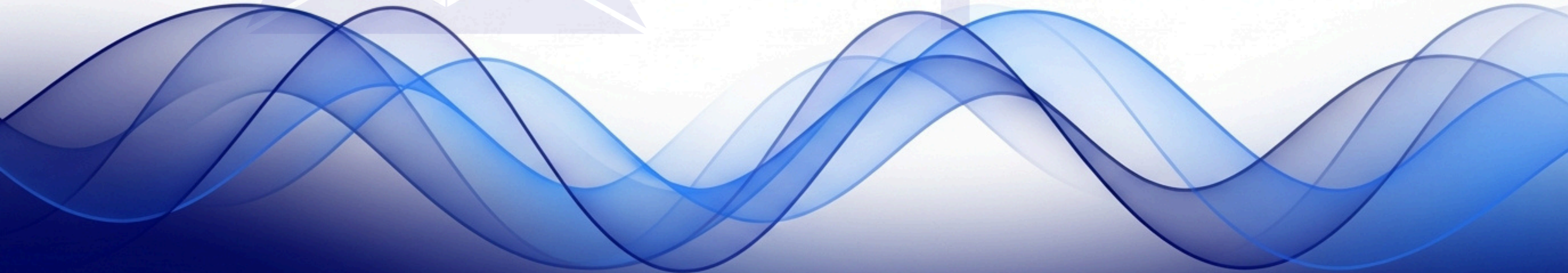


Period, Angular Frequency & Frequency

Mastering the Temporal Parameters of Wave Motion

NEET / JEE Foundation Module • Section 14.3.3



H2. The Time Perspective of a Wave

If we fix our attention on one single location (e.g., $x = 0$), the wave equation simplifies. We are no longer watching the wave travel; we are watching a single particle bounce up and down in place.

$$y(0, t) = -a \sin(\omega t)$$

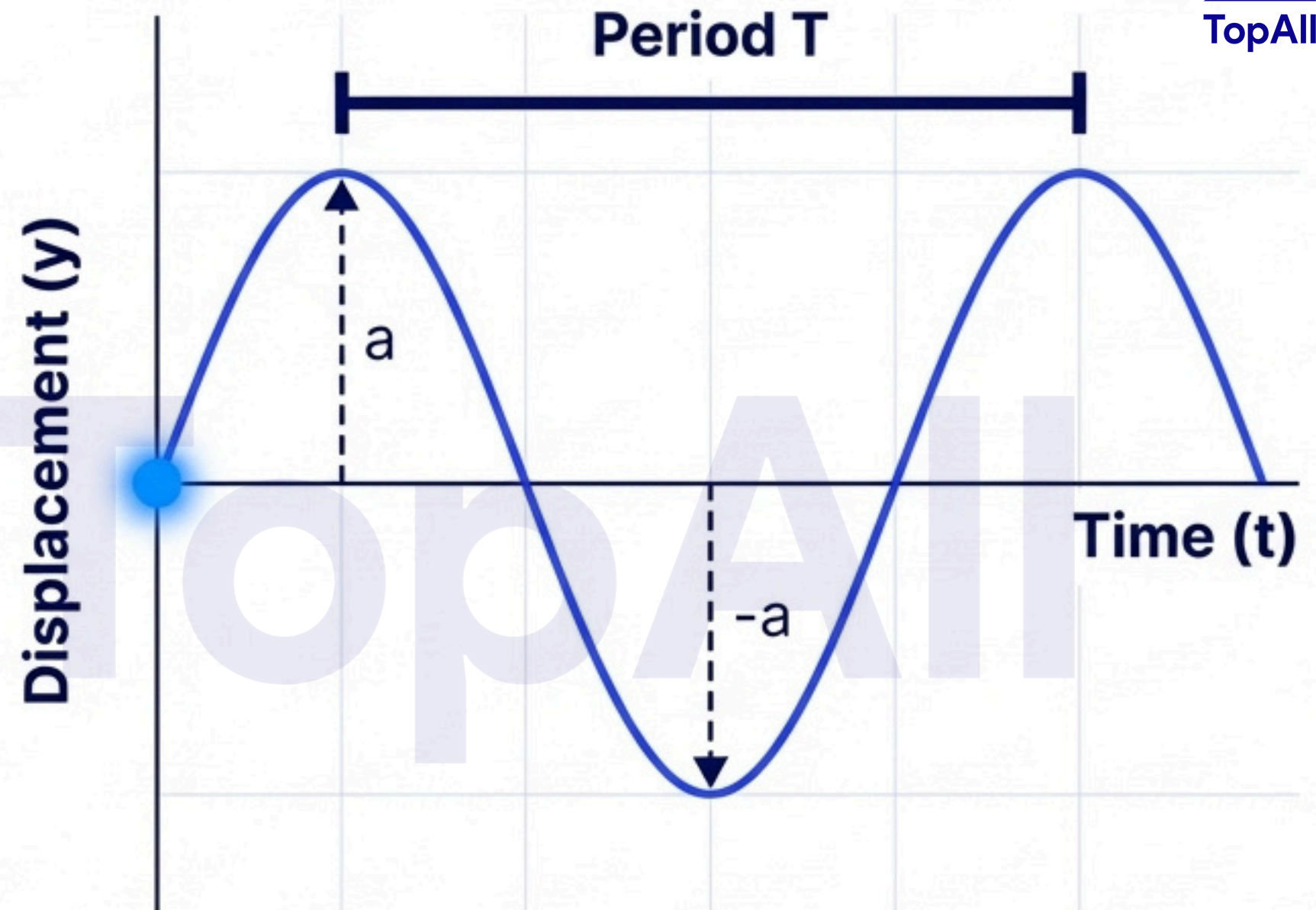
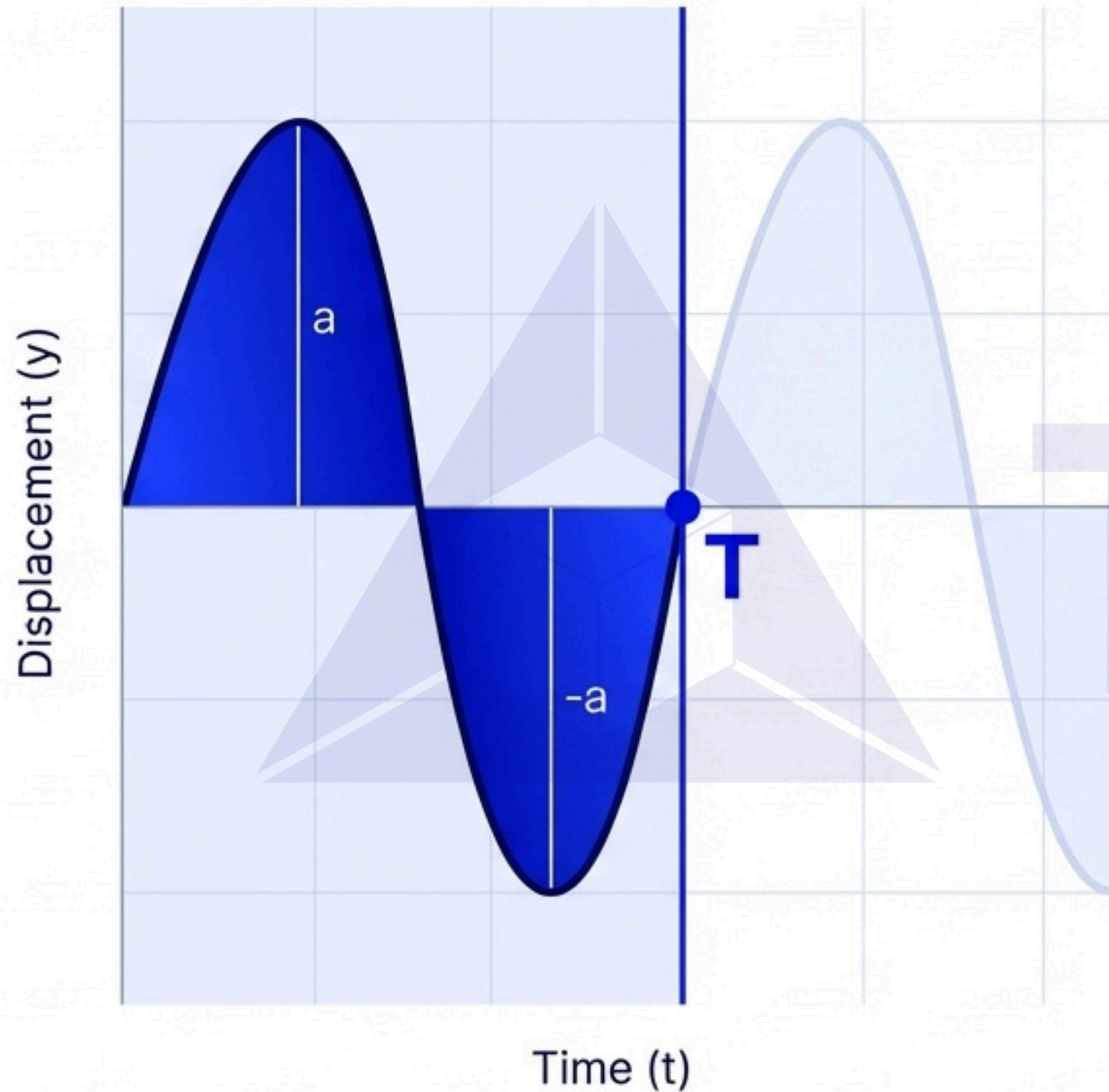


FIG. 14.7: Displacement of an element at a fixed location.



Period (T): Completing the Oscillation

The Period is the exact amount of time it takes for an element of the medium to complete one full oscillation and return to its initial phase.

- Because a sine function repeats every 2π , the physical cycle resets when $\omega T = 2\pi$.
- It is measured in seconds (s).

$$T = \frac{2\pi}{\omega}$$



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$$E=mc^2$$



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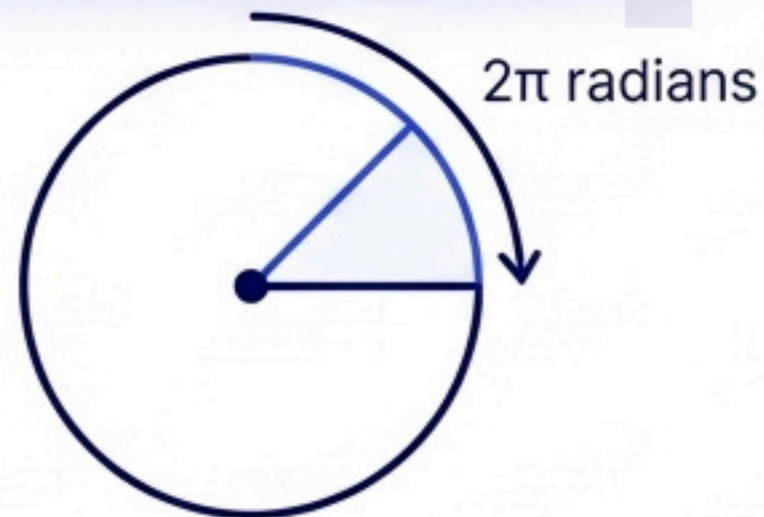


Angular Frequency (ω): The Rate of Phase Change

How Fast Does the Phase Shift?
Angular frequency (ω) dictates how rapidly the argument of the sine function changes with time.

$$\omega = \frac{2\pi}{T}$$

- Represents the angle (in radians) covered per unit of time.
- The SI Unit is rad s^{-1} .



Frequency (ν): Oscillations Per Second

While Period measures the time per oscillation, standard **Frequency** measures the oscillations per unit of time. They are perfect mathematical inverses.

- Frequency represents the total number of wave cycles completed in one second.
- The SI Unit is the hertz (Hz).

$$\nu = \frac{1}{T}$$

3 Hz



The Unified Relationship



$$v = \frac{1}{T} = \frac{\omega}{2\pi}$$

LONGITUDINAL WAVES

The temporal math applies perfectly to longitudinal waves (like sound), where displacement is parallel to propagation. We simply replace vertical displacement y with longitudinal displacement s .

$$s(x,t) = a \sin(kx - \omega t + \phi)$$

Key Takeaways: Mastering Time in Waves

PERIOD (T):	Time taken for one complete oscillation (seconds).
ANGULAR FREQUENCY (ω):	Rate of phase change (rad s^{-1}).
FREQUENCY (ν):	Number of oscillations per second (Hz).
UNIVERSAL LINK:	$\nu = \frac{1}{T} = \frac{\omega}{2\pi}$ Applies to both Transverse (y) and Longitudinal (s) waves.

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