

Demystifying Amplitude & Phase (H1, 32px)

The Mathematical Blueprint of a Travelling Wave (H2, 24px)



The diagram shows the wave equation $y(x,t) = a \sin(kx - \omega t + \phi)$ with arrows pointing to each term: $y(x,t)$, a , kx , ωt , and ϕ . A large, faint 'TopAll' watermark is visible in the background.

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

Master the foundational wave equation for NEET/JEE.

Amplitude: The Physical Limit

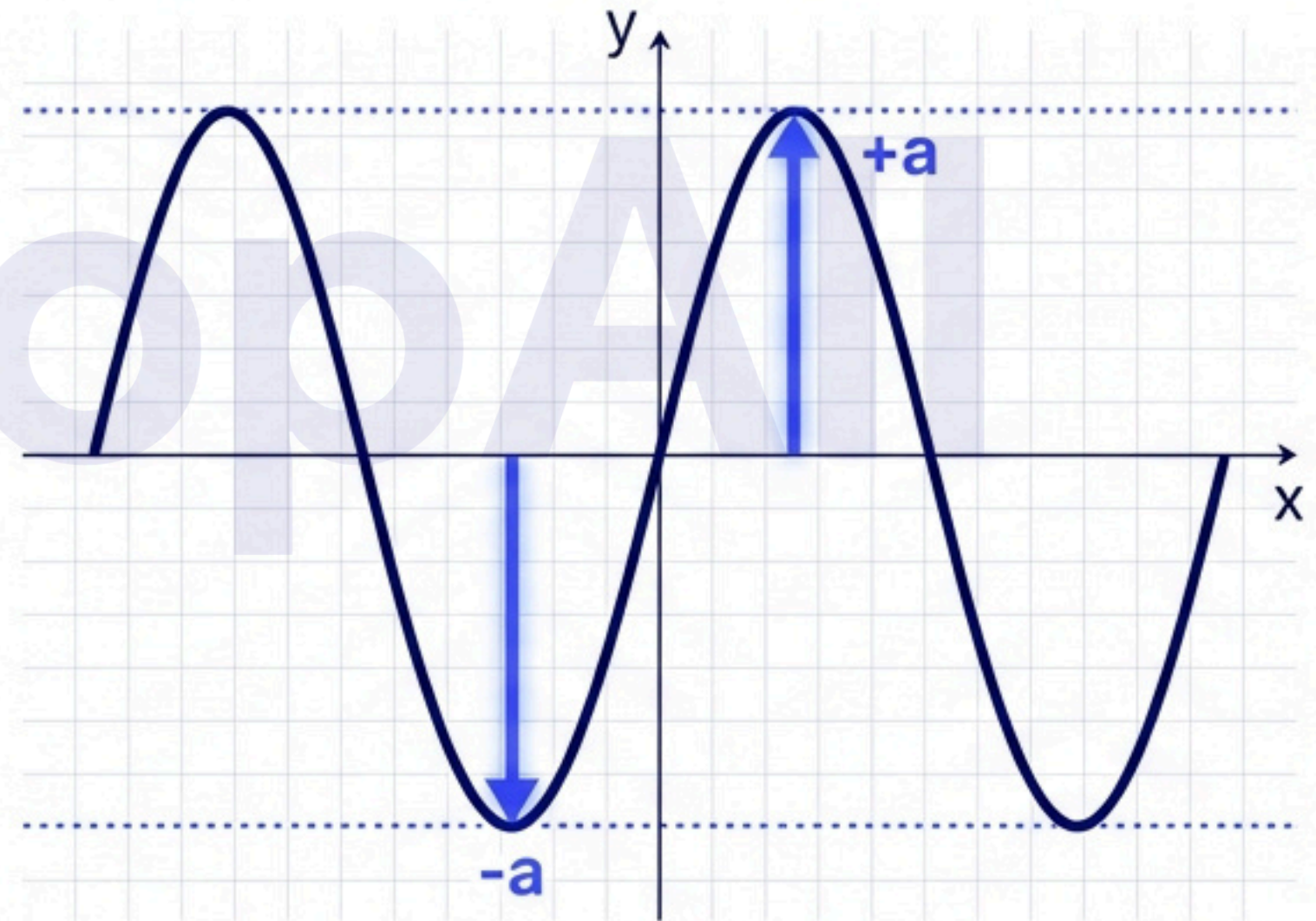
$$y(x,t) = a \sin(kx - \omega t + \phi)$$

Amplitude as Maximum Displacement

- The wave function $y(x,t)$ oscillates strictly between $+a$ and $-a$.
- a is always a positive constant.
- It defines the absolute maximum distance a constituent of the medium moves from its resting equilibrium.



EXAM TIP: Do not confuse total wave height (crest-to-trough, $2a$) with Amplitude (a).

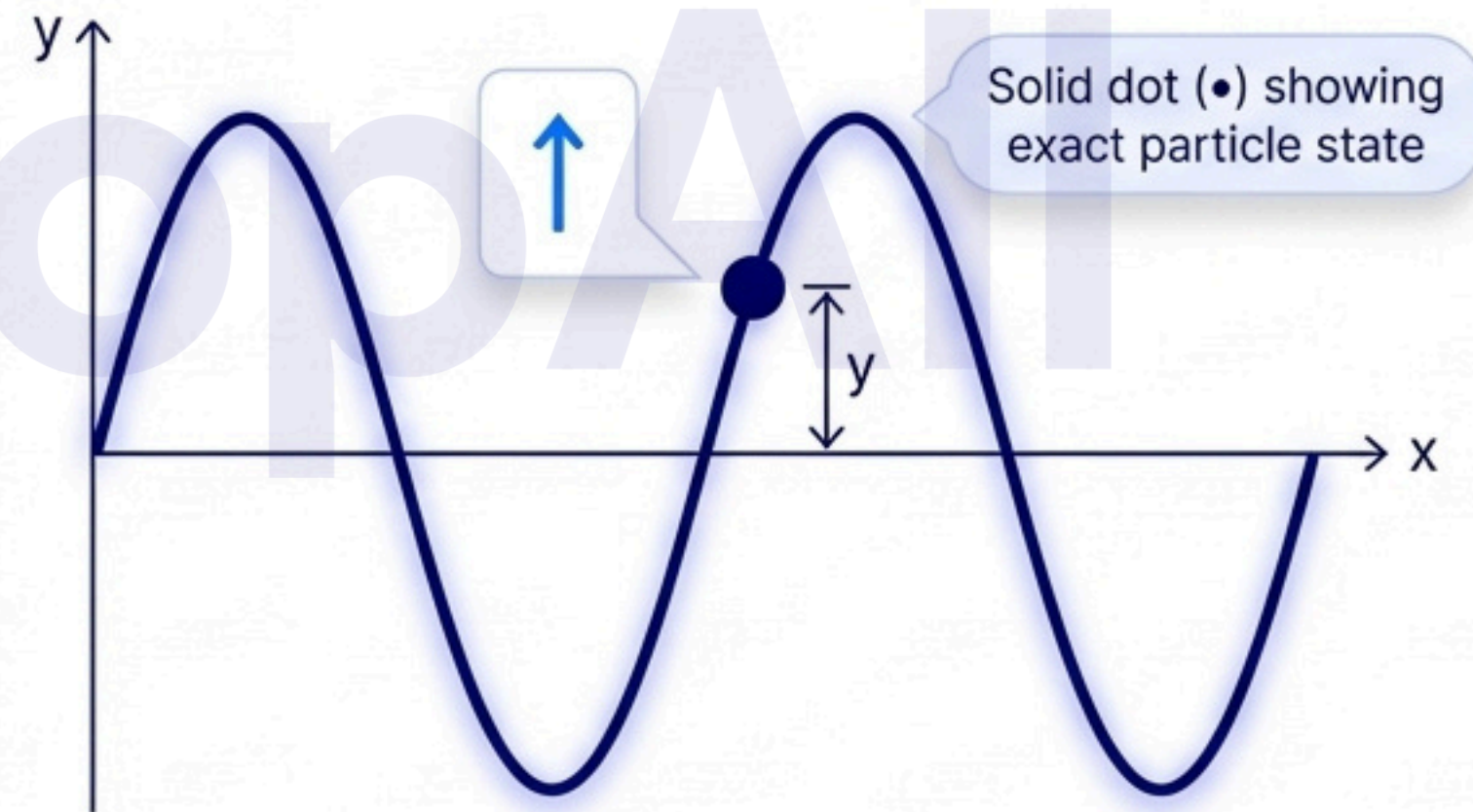


Phase: The State of Oscillation

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

What Phase Means

- Phase is the entire argument of the sine function: $(kx - \omega t + \phi)$.
- It locks in the exact state of oscillation of a particle.
- Given amplitude a , the phase determines a particle's precise displacement and direction at any position (x) and instant (t) .





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$$E=mc^2$$



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Tracking the Wave via Phase

Locating Crests and Troughs

- A crest is simply a point of maximum positive displacement (constant phase).
- To track how a wave travels, fix attention on a single crest (×).
- As time (t) increases, position (x) must also increase to keep the phase ($kx - \omega t + \phi$) constant.

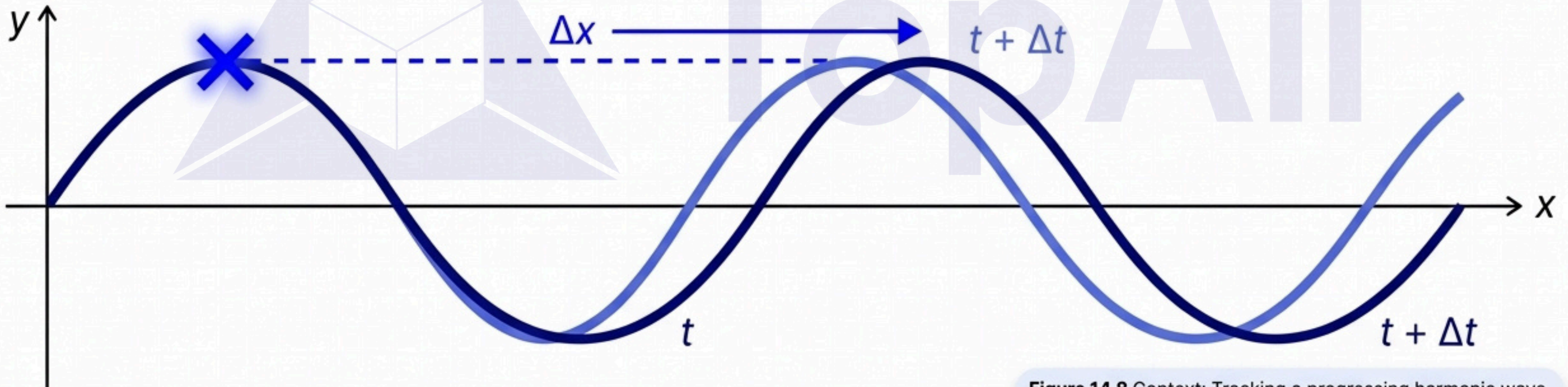


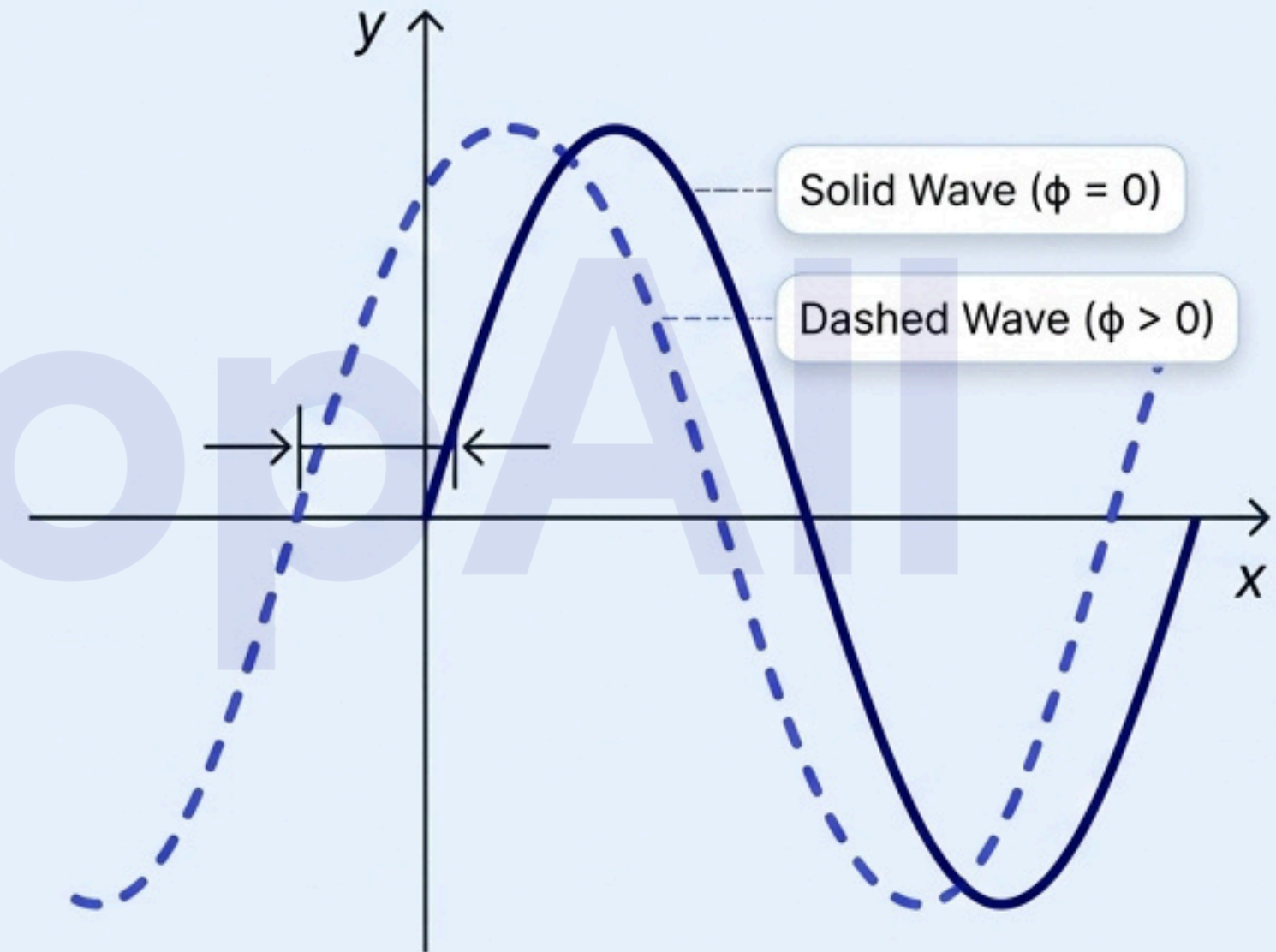
Figure 14.8 Context: Tracking a progressing harmonic wave.

Initial Phase Angle (ϕ): The Starting Offset

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

Same Wave, Different Start

- ϕ is the initial phase angle at $x=0$ and $t=0$.
- It determines where the wave cycle begins on the displacement axis.
- By smartly choosing our origin and starting time, we can often set $\phi = 0$ to simplify calculations.

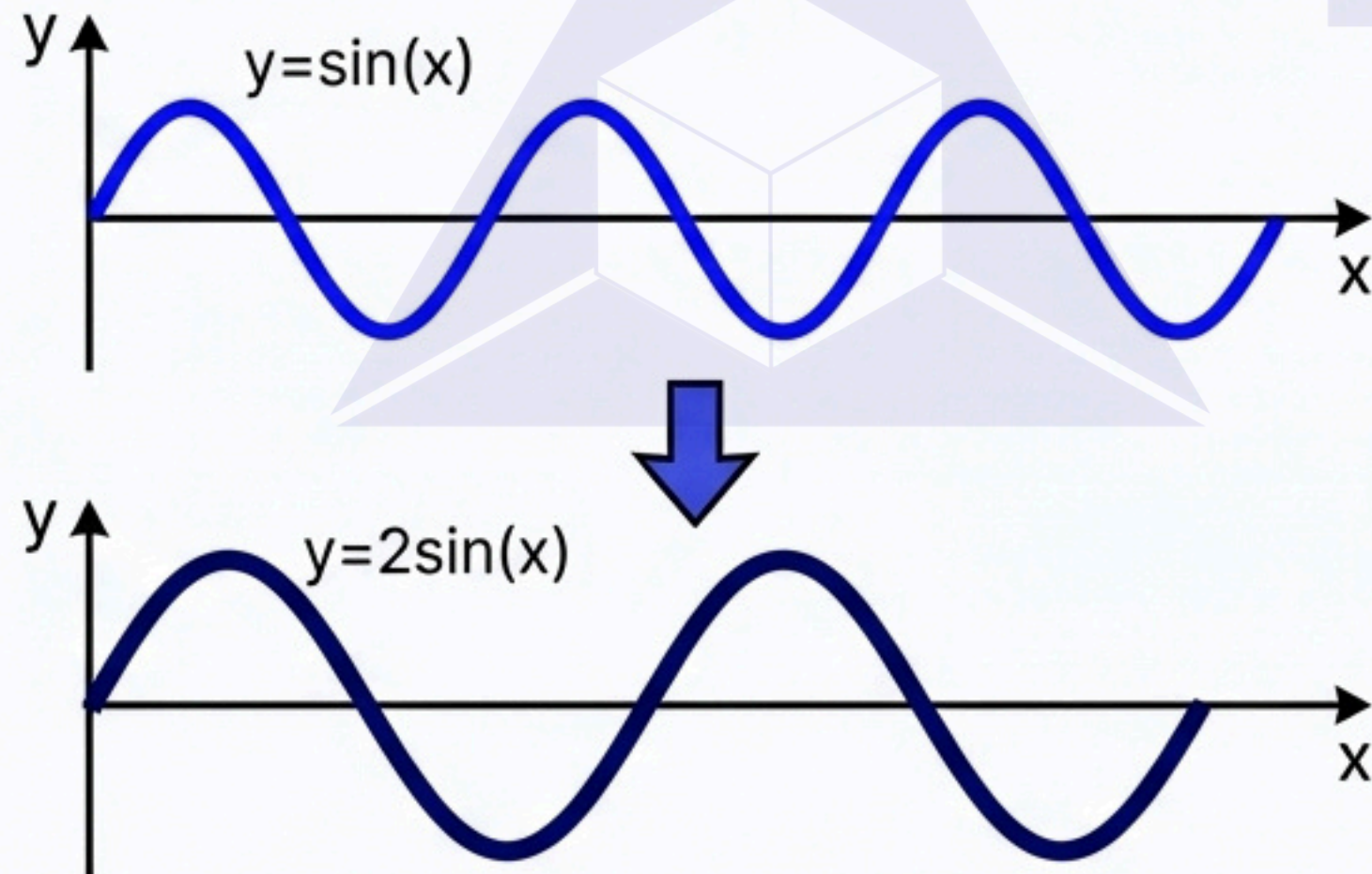


Synthesis: Why Phase is the Master Key

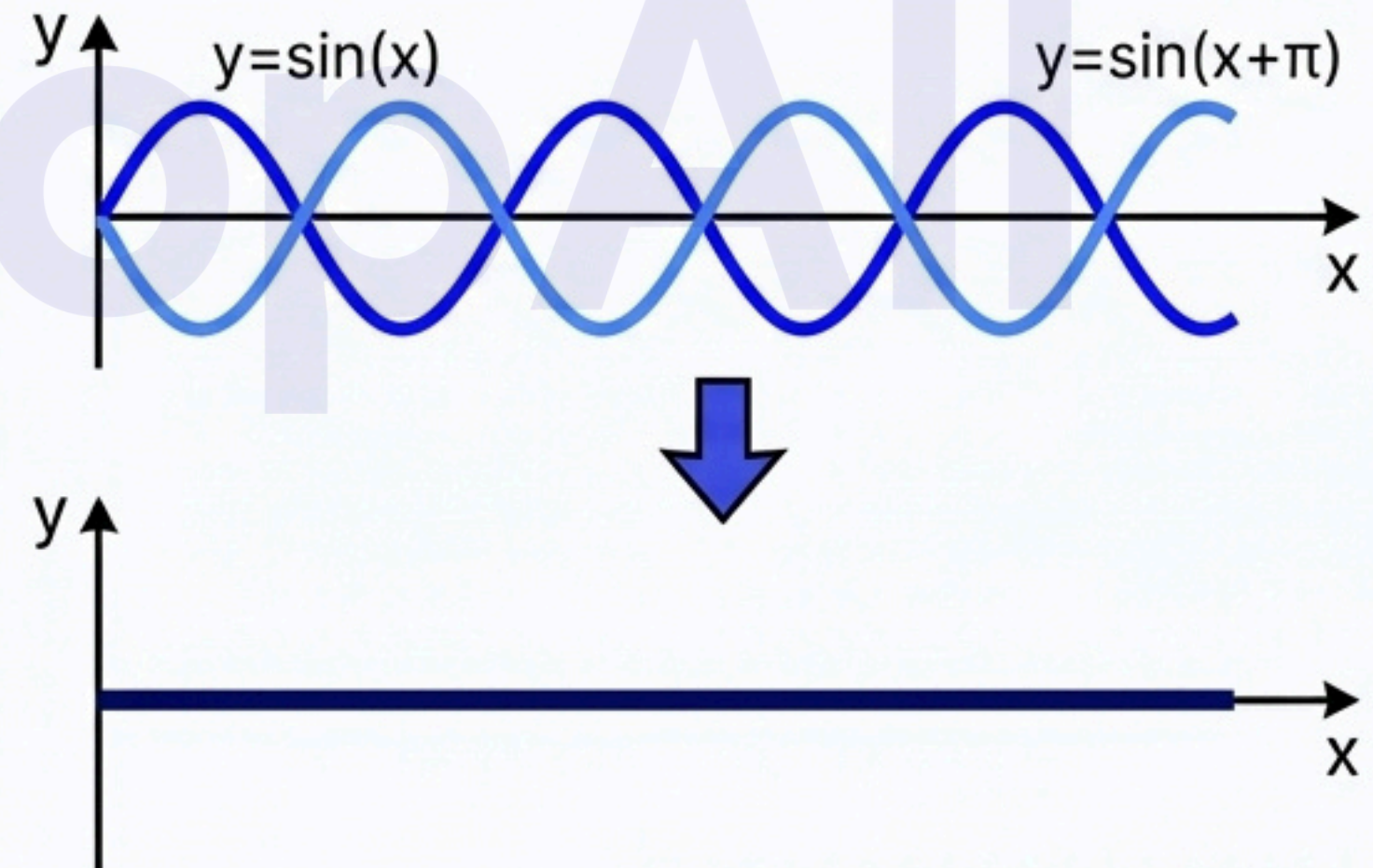
Predicting Wave Interactions

- Phase isn't just a label—it dictates how multiple waves interact in a medium (Superposition).
- If you don't know the phase, you cannot predict the resultant wave.

Constructive Interference



Destructive Interference



Chapter 14.3.1 Mastered

Plus Jakarta Sans, 32px, Navy (#000080)



Key Takeaways

- ✓ **Amplitude (a):** The strict physical limit of maximum displacement from equilibrium.
- ✓ **Phase ($kx - \omega t + \phi$):** The master mathematical argument that dictates a particle's exact state of oscillation.
- ✓ **Initial Phase (ϕ):** The starting offset at $x=0$, $t=0$, which can often be simplified to zero.

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