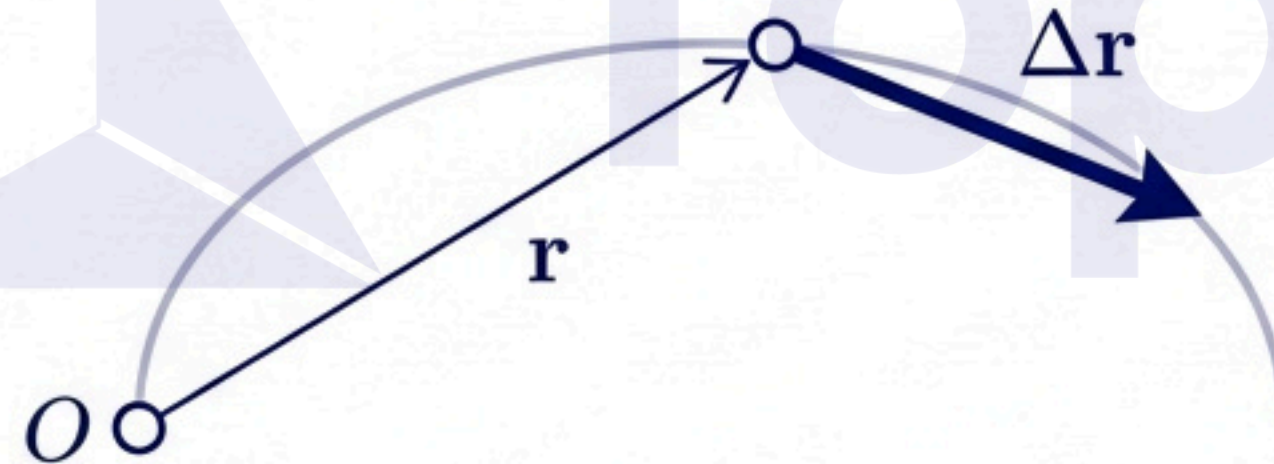


CHAPTER 3.7.1 • MOTION IN A PLANE

Position Vector and Displacement in 2D Motion

Mastering the mathematical language of two-dimensional motion through vectors, coordinates, and components.

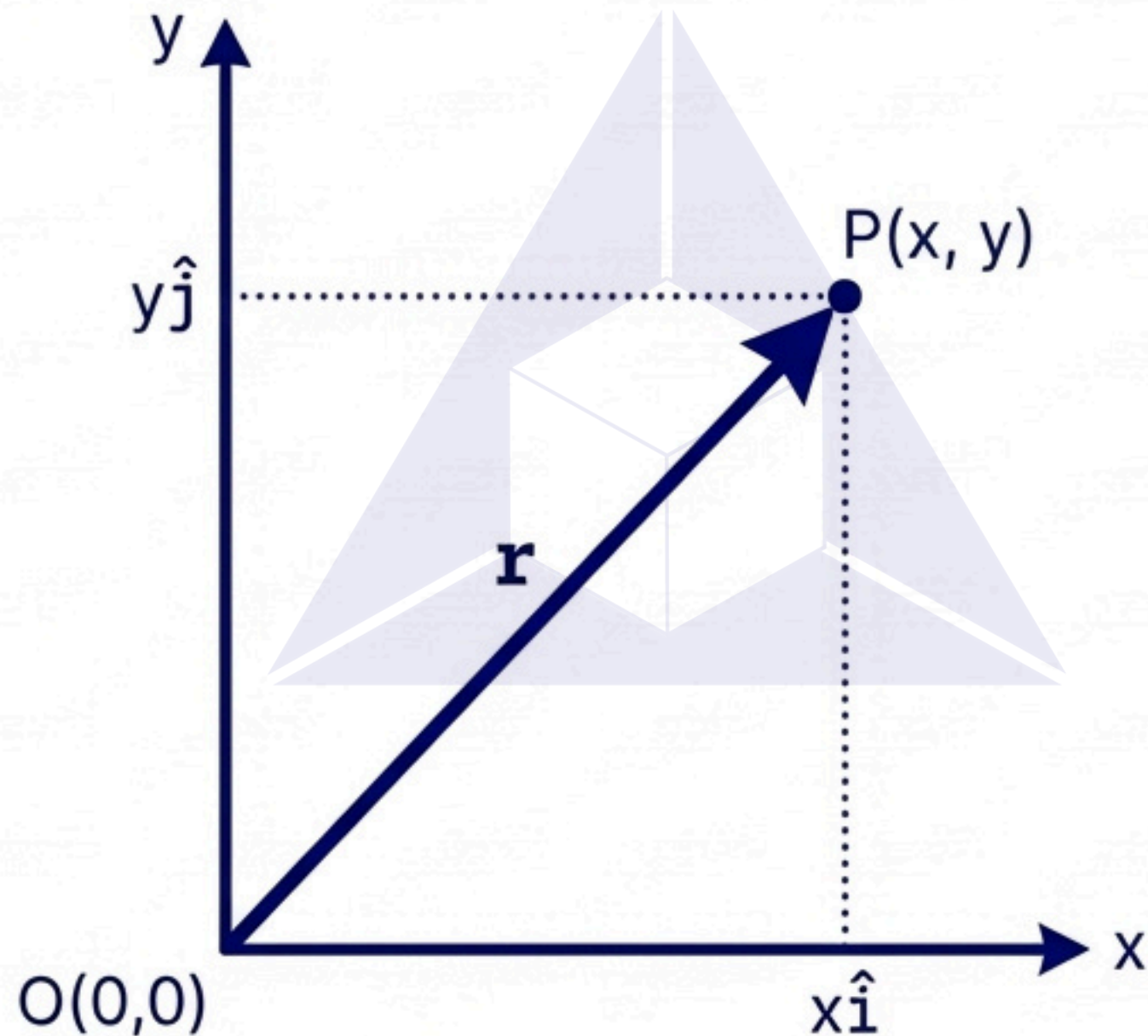


Exam-Smart Summary

Core Physics Concepts

5-Minute Mastery

Defining the Position Vector



To describe the position of an object moving in a plane, we establish a reference frame with an origin O . The straight-line vector from O to the object's location P is its position vector.

The coordinates (x, y) dictate how far the object is along the x -axis and y -axis. We map these algebraically using the orthogonal unit vectors $\hat{i}$ and $\hat{j}$.

$$\mathbf{r} = x\hat{i} + y\hat{j}$$



Pro-Tip: The length of vector $\mathbf{r}$ (its magnitude) is simply the straight-line distance from the origin, found using the Pythagorean theorem: $|\mathbf{r}| = \sqrt{x^2 + y^2}$.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



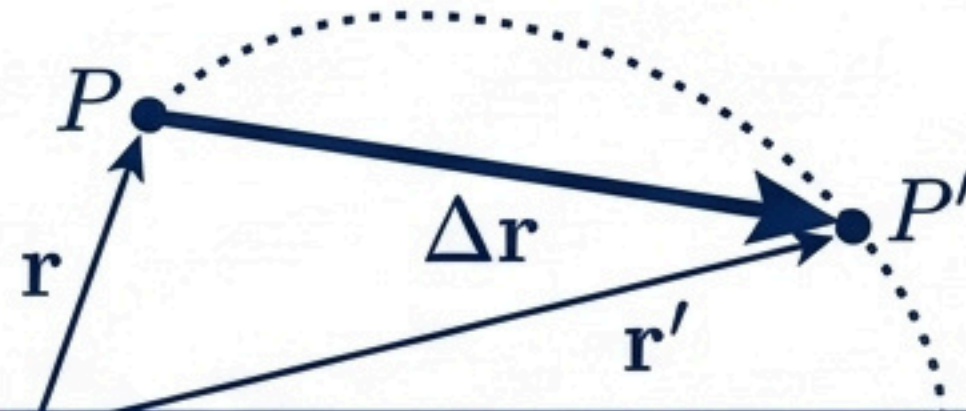
At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Displacement Between Two Instants



The Journey: As an object moves arbitrarily along a curved trajectory from P to P', its position vector changes from $\mathbf{r}$ to $\mathbf{r}'$.

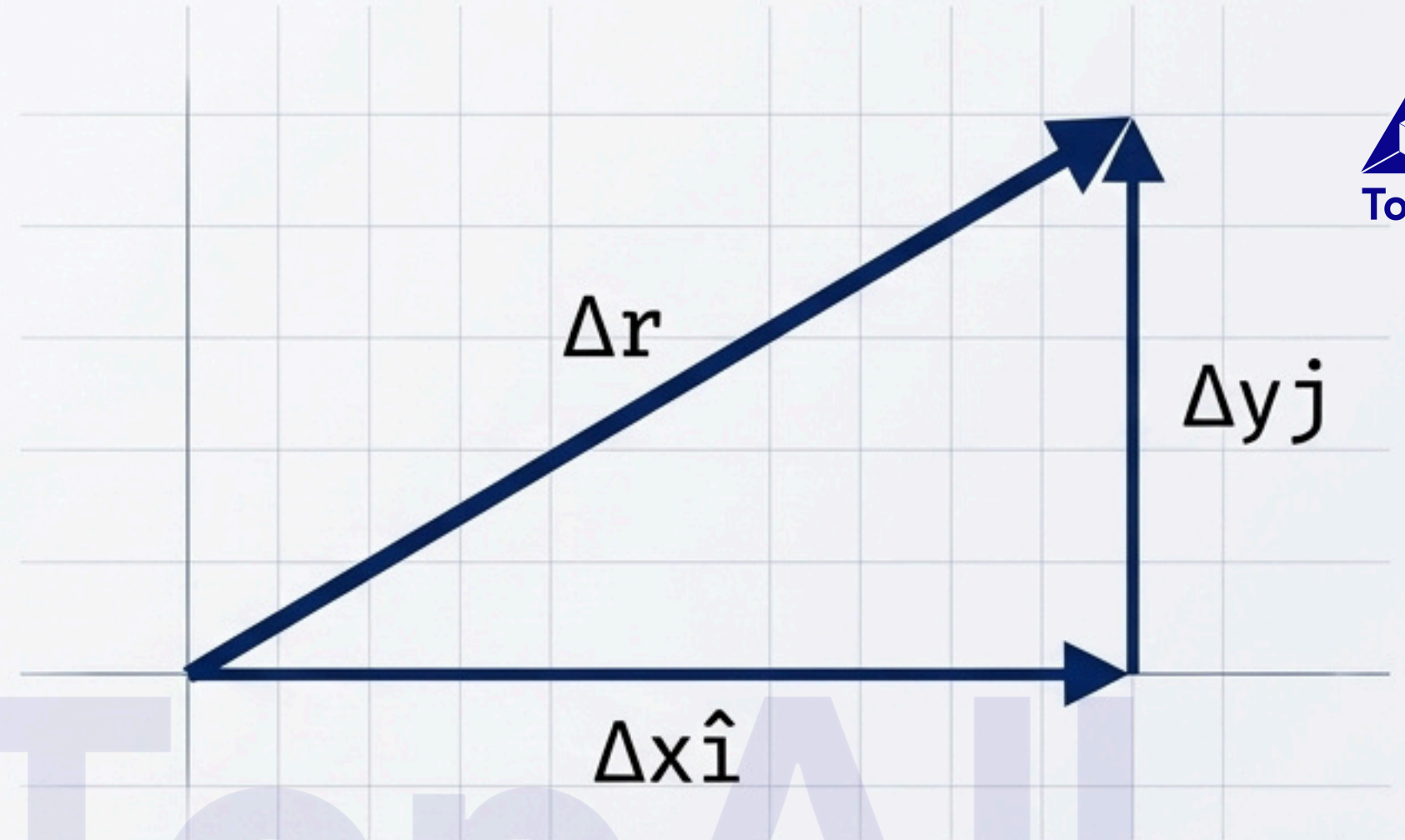
The Result: The displacement $\Delta \mathbf{r}$ is the straight-line vector connecting the initial position directly to the final position. It depends only on the endpoints, completely ignoring the path taken.

$$\Delta \mathbf{r} = \mathbf{r}' - \mathbf{r}$$



Exam Insight: Displacement is the literal difference between two position vectors. Graphically, you draw it by placing the tail at the starting point P and the tip at the final point P'.

The Component Form of Displacement



2D motion is mathematically identical to two 1D motions happening simultaneously. We can cleanly break down the total diagonal displacement into independent horizontal and vertical steps.

$$\Delta x = x' - x$$

$$\Delta y = y' - y$$

$$\Delta \mathbf{r} = \Delta x \hat{i} + \Delta y \hat{j}$$

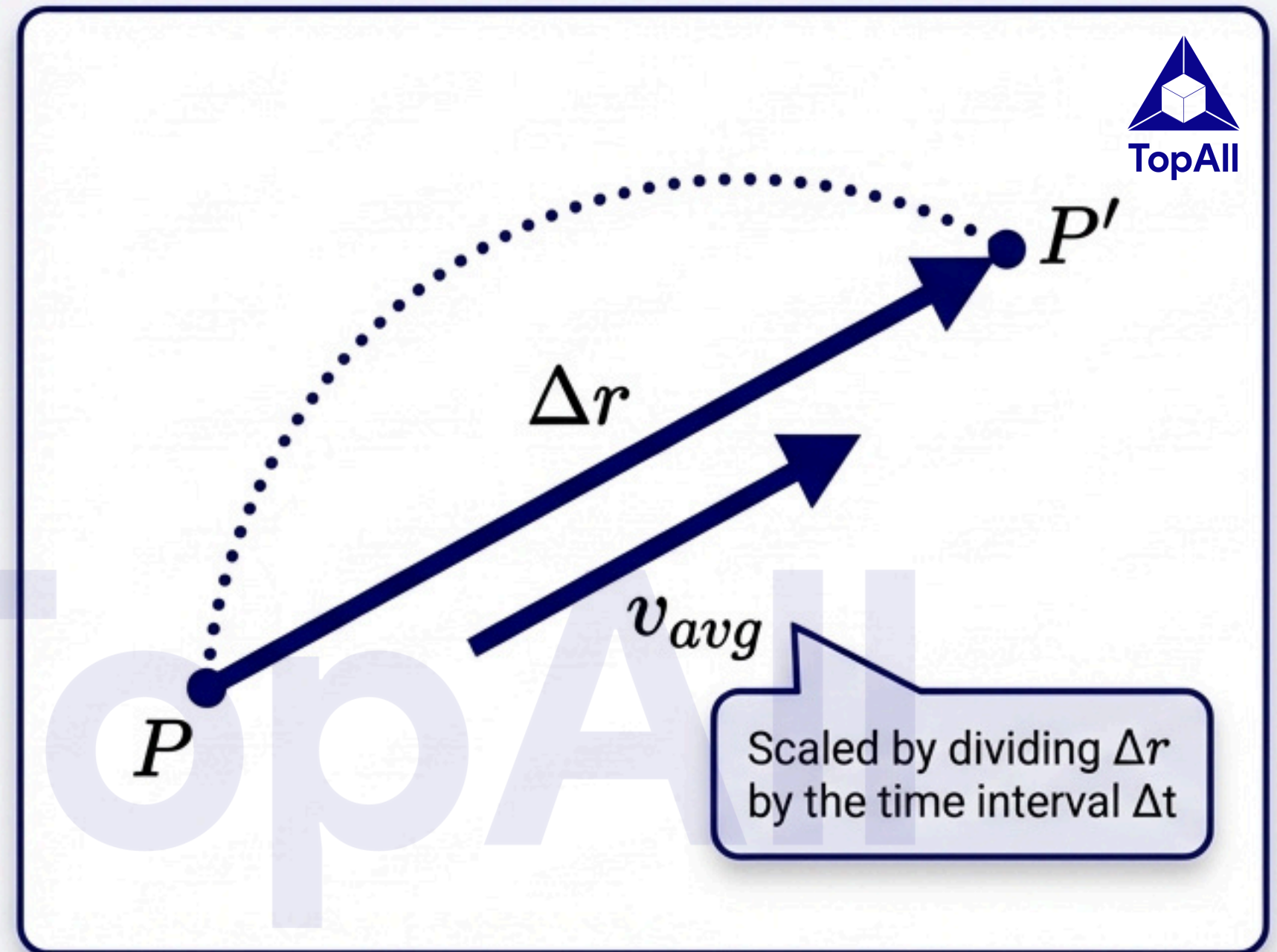


The Math Translation: We subtract the initial x-coordinate from the final x-coordinate to get Δx , and do the exact same for y. We then combine them back into a single vector using the unit vectors $\hat{i}$ and $\hat{j}$.

The Link to Average Velocity

Displacement tells us where and how far an object moved. By dividing that displacement by the time interval (Δt) it took to move, we unlock the concept of Average Velocity.

Because time (Δt) is always a positive scalar, dividing the vector $\Delta \mathbf{r}$ by Δt scales its length but does not change its orientation. Average velocity always points in the exact same direction as displacement.



$$\mathbf{v}_{avg} = \frac{\Delta \mathbf{r}}{\Delta t}$$



Next Steps: In component form, this is $\mathbf{v}_{avg} = (\Delta x / \Delta t) \hat{i} + (\Delta y / \Delta t) \hat{j}$. If we shrink the time interval to mathematically zero ($\Delta t \rightarrow 0$), this average becomes the **instantaneous velocity**!



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis