

Motion in a Plane · Concept 3

Vector Addition and Subtraction — Graphical Method

Visualizing vector operations using triangle and parallelogram geometric frameworks.

The Triangle Method of Addition

1. The Elements

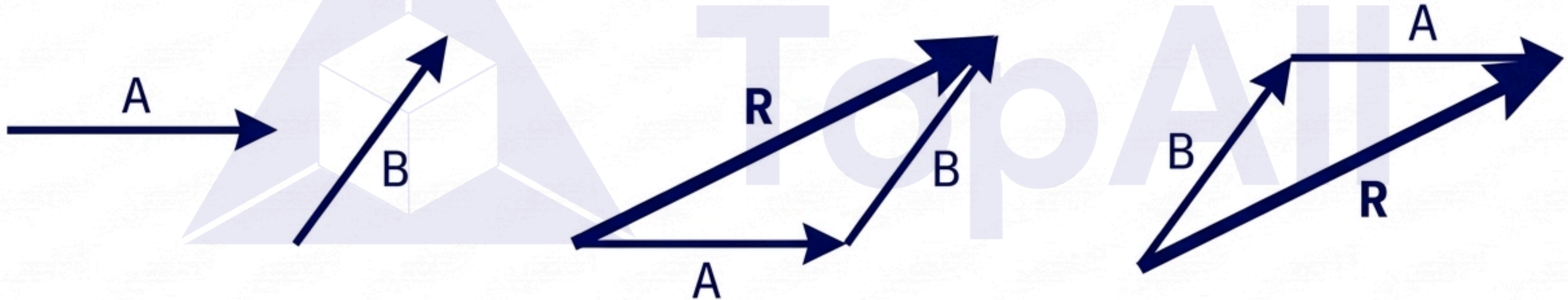
To add two vectors graphically, we represent their magnitudes via proportional line lengths and maintain their exact directions.

2. The Construction

Place the tail of vector B at the head of vector A. The straight line joining the tail of A to the head of B represents the resultant vector R.

3. The Commutative Law

Vector addition is independent of order. If we place A at the head of B, the resultant R remains identical.



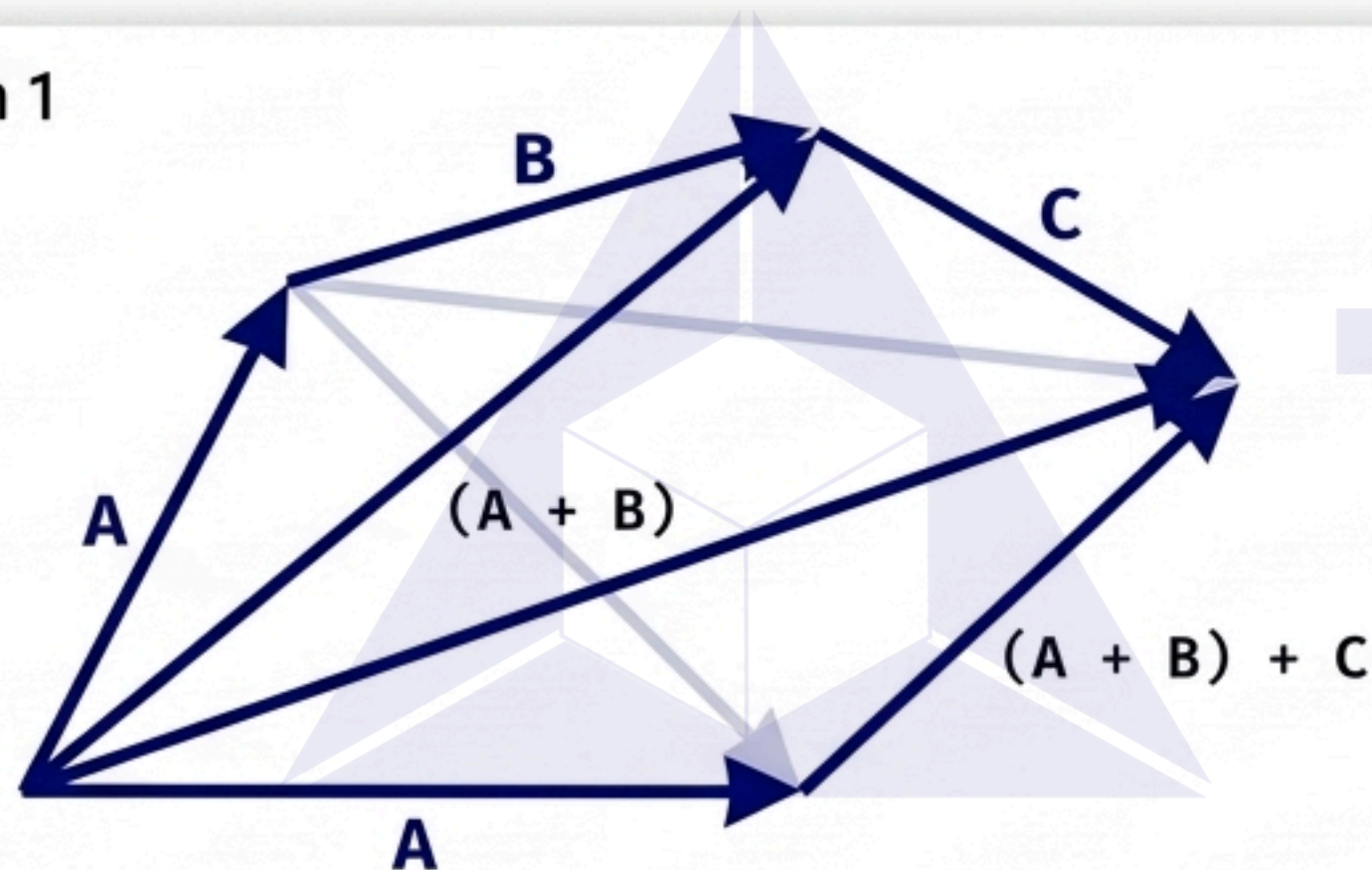
Addition is Commutative: $A + B = B + A$

Vector Addition is Associative

Grouping does not change the resultant.

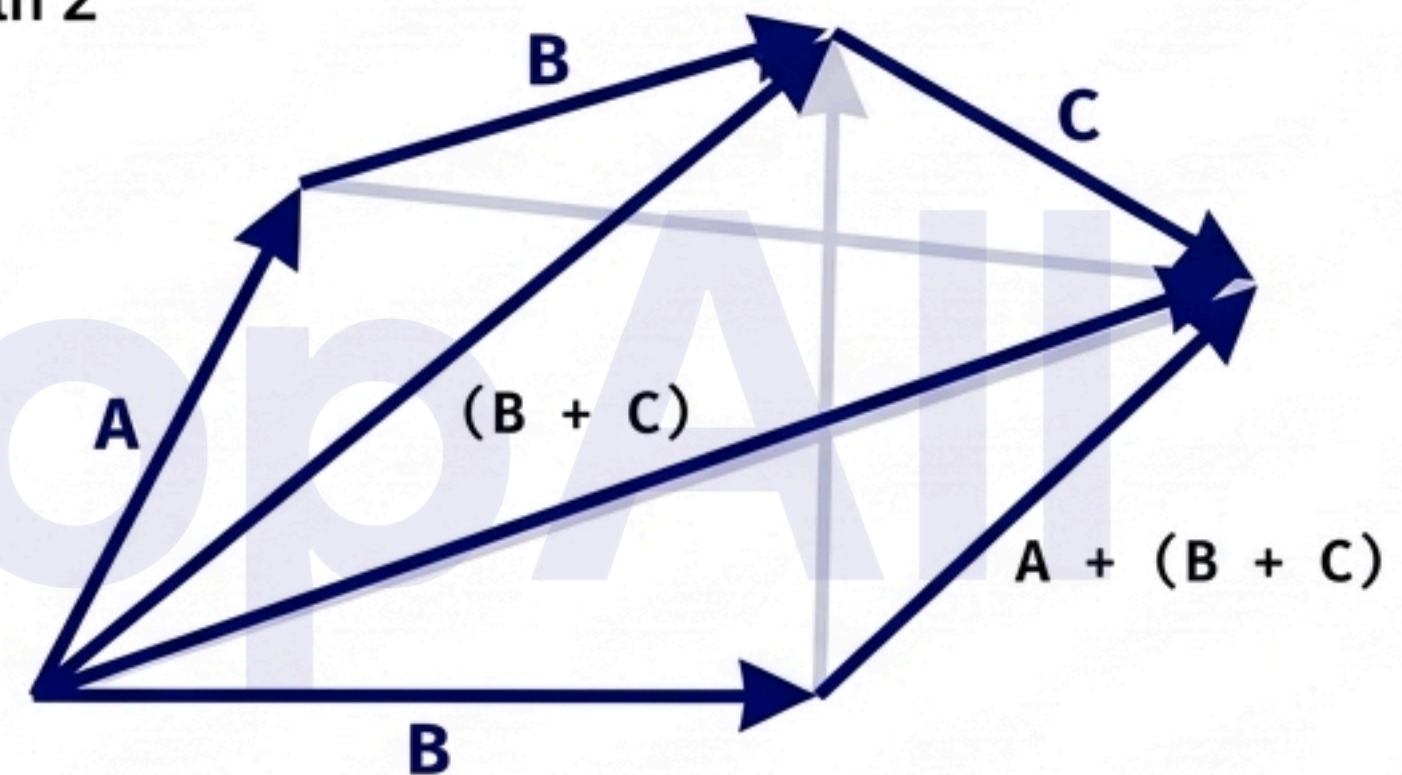
When adding three or more vectors, the result is identical regardless of which two vectors are added together first.

Path 1



Add **A** and **B** first. Then add **C** to the resultant **(A + B)**.

Path 2



Add **B** and **C** first. Then add the resultant **(B + C)** to **A**.

$$(A + B) + C = A + (B + C)$$



**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.**

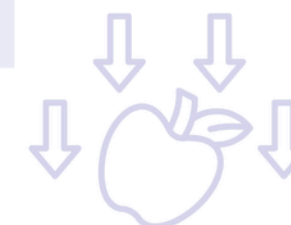
Practice Now



At prep.topall.app

Key Highlights

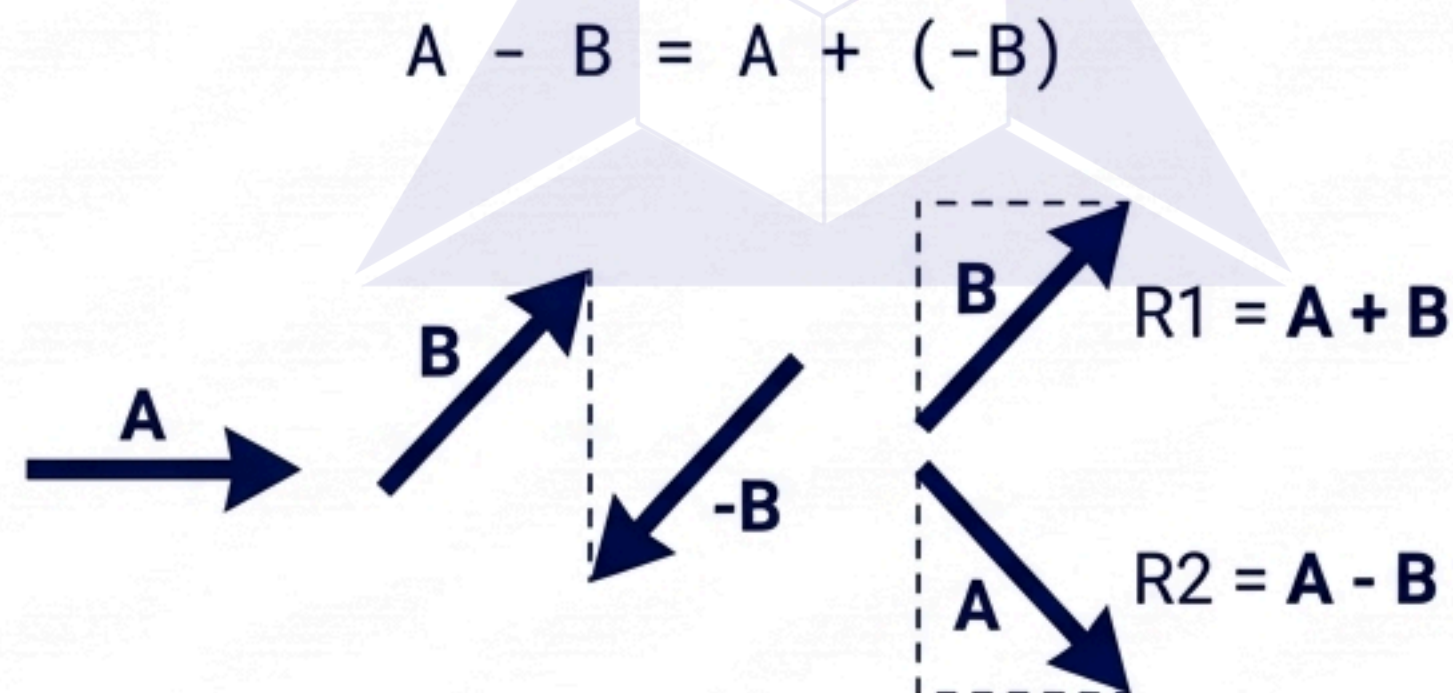
- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Vector Subtraction & Null Vectors

Subtraction is Adding the Negative

We define the difference of two vectors as the sum of a vector and a reversed vector. Multiplying a vector by -1 reverses its direction while keeping its magnitude identical.



Zero Magnitude, Undefined Direction

What happens when you add two equal and opposite vectors? The resultant has zero magnitude. This is the null vector ($\mathbf{0}$).

Physical meaning: Displacement of an object that returns to its exact starting point.

$$A - A = \mathbf{0}$$

$$|\mathbf{0}| = 0$$

$$A + \mathbf{0} = A$$

$$\lambda \mathbf{0} = \mathbf{0}$$

$$0A = \mathbf{0}$$

Common Pitfalls



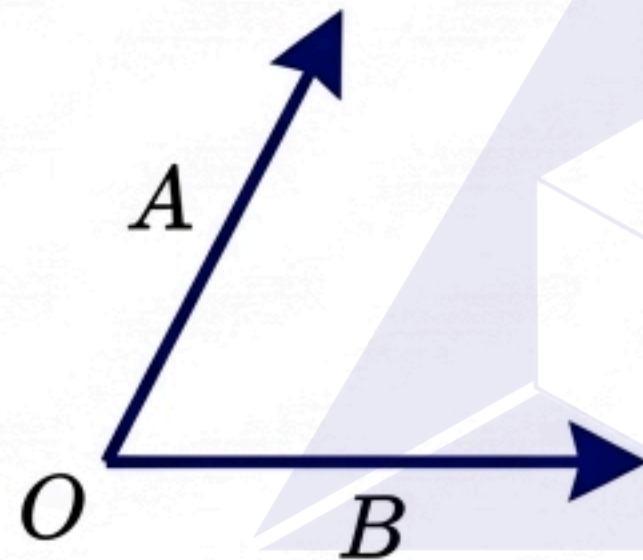
TRAP ALERT

A null vector's direction cannot be specified — its magnitude is zero.

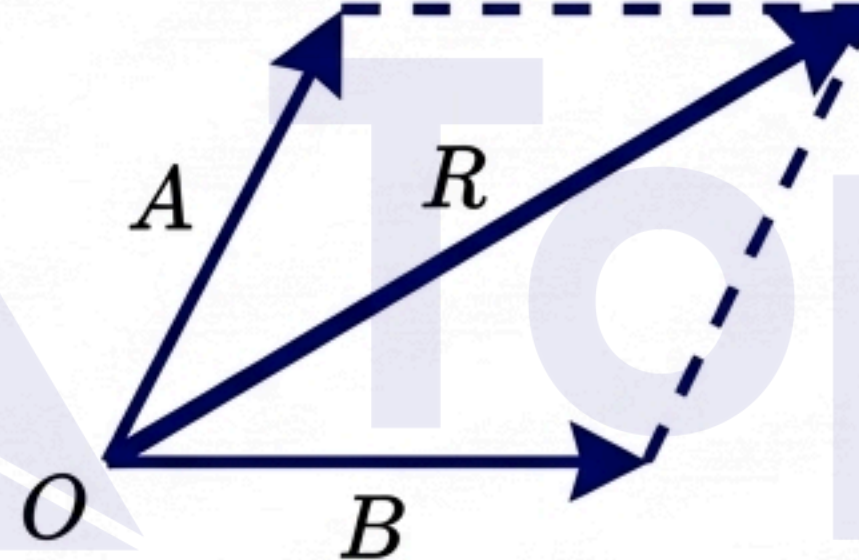
And **subtraction** always means reversing the second vector before adding.

The Parallelogram Method

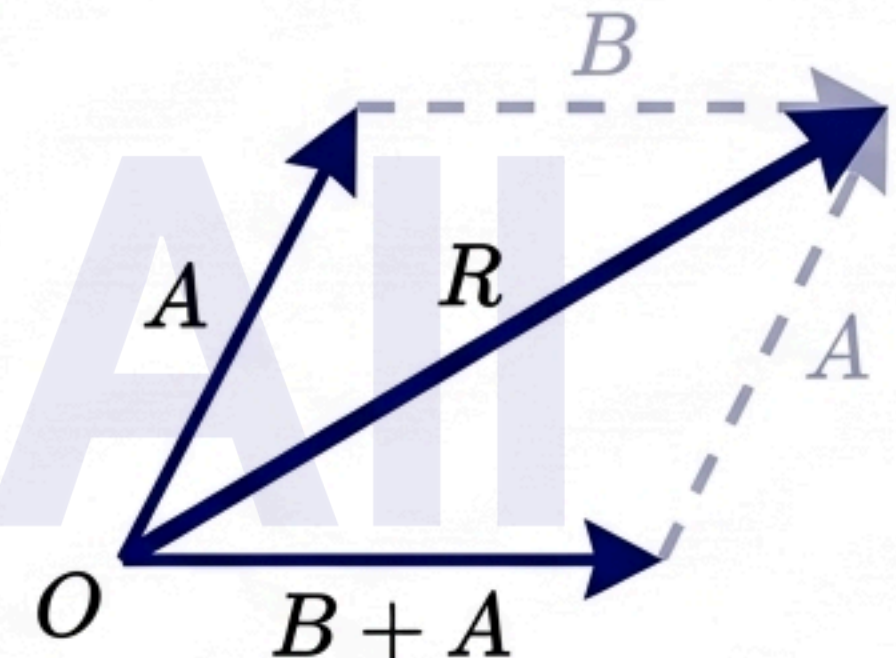
An alternative to the head-to-tail method is the **tail-to-tail** assembly, useful when vectors originate from a common point.



Bring the tails of vectors **A** and **B** to a common origin **O**.



Draw a line from the head of **A** parallel to **B**, and from the head of **B** parallel to **A**, completing the parallelogram. The diagonal from origin **O** is the resultant **R**.



Geometric Equivalence

The triangle method yields the exact same resultant. The two methods are geometrically identical; they simply represent different halves of the same parallelogram.

Application: Relative Motion

Example 3.1

Rain is falling vertically with a speed of 35 m/s. Winds start blowing after sometime with a speed of 12 m/s in east to west direction. In which direction should a boy waiting at a bus stop hold his umbrella?

Solution:

The velocity of the rain ($\mathbf{v}_r$) and the wind ($\mathbf{v}_w$) are represented by vectors. We must find their resultant $\mathbf{R}$.

1. Magnitude:

$$R = \sqrt{v_r^2 + v_w^2}$$

$$R = \sqrt{35^2 + 12^2}$$

$$R \approx 37 \text{ m/s}$$

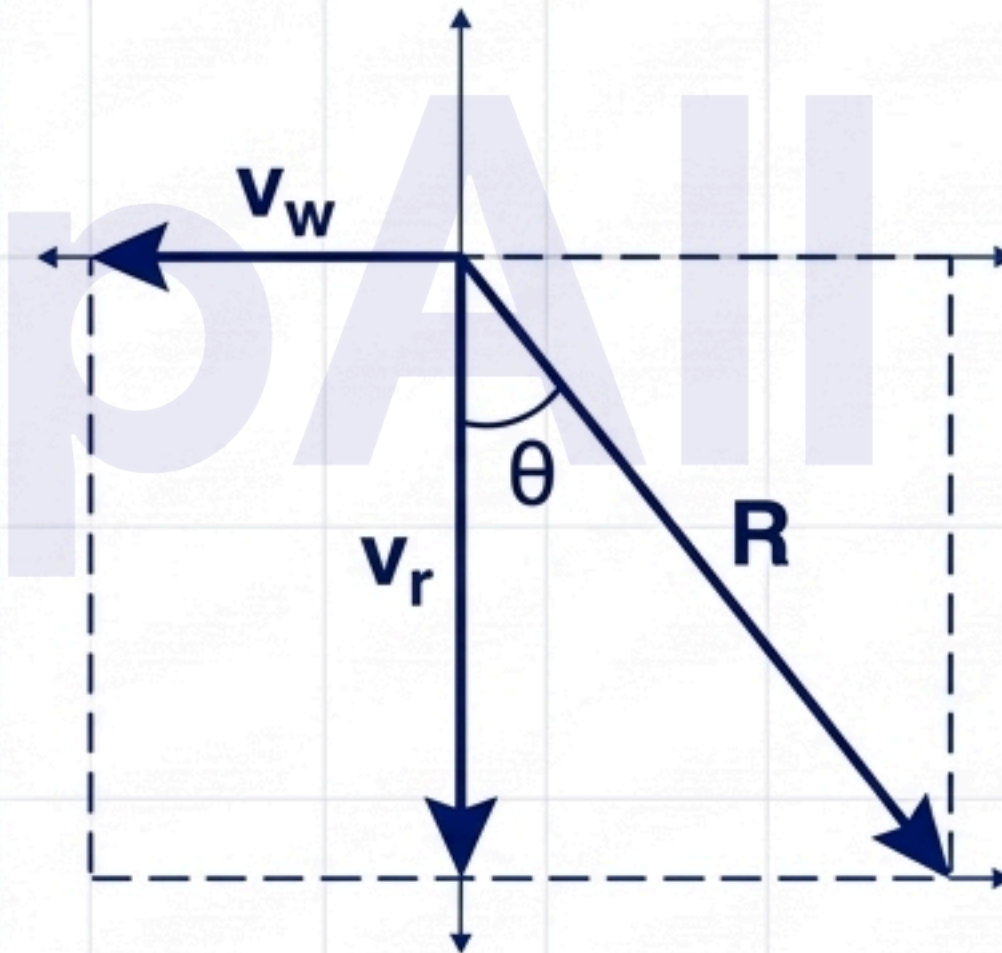
2. Direction:

Let θ be the angle $\mathbf{R}$ makes with the vertical ($\mathbf{v}_r$).

$$\tan \theta = v_w / v_r = 12 / 35 \approx 0.343$$

$$\theta = \tan^{-1}(0.343) \approx 19^\circ$$

Result: The boy should hold his umbrella in the vertical plane at an angle of $\sim 19^\circ$ with the vertical towards the east.



Concept Summary



Key Takeaways

Addition is commutative and associative; subtraction is adding the negative; triangle and parallelogram methods give identical results.



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