Vector component

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1. **What is Unit ?**
    - In physics, a **unit** is a standard quantity used to measure physical properties like length, time, mass, temperature, etc. Units help us compare and quantify things accurately.

    - Scalar and Vector Quantities

Type	What it Means	Example	Unit Type Used
Scalar	Only magnitude (no direction)	Mass,time,speed, Temperature	Scalar Units
Vector	These measure vector quantities. They must include direction with the unit	Displacement→ meter (m) in a direction. e.g., 10 m east , Velocity,Force	Vector units

2. **What is a Vector?**

    A vector is a quantity that has both magnitude and direction.

    Magnitude means the "size" or "amount".

    Direction means where it is pointing.

- Examples of Vector Quantities:

    A. Displacement – 5 km north
    B. Velocity – 20 m/s towards east
    C. Force – 10 newton to the right

These can't be fully described just by a number — you need to say where they go.

- Representing a Vector:

  A vector is usually drawn as an arrow.
  The length of the arrow shows the magnitude.
  The arrowhead shows the direction.

We write vectors with a bold letter or an arrow on top, like A or →A.

- Vector Addition (Triangle Rule):

To add two vectors:

A. Place the second vector’s tail at the tip of the first.

B. Draw a vector from the start of the first to the tip of the second — that’s the resultant.

This is called the Triangle Law of Vector Addition.

- Important Vector Operations:

Addition & Subtraction – combine or find the difference of two vectors.

Multiplication by a Scalar – changes the magnitude, not the direction.

Unit Vector – a vector with magnitude 1, shows only direction.

3. **What is a Unit Vector?**

A unit vector is a vector that has a magnitude (length) of 1 unit and shows only direction, not size.

It’s used to tell direction clearly in space — like pointing north, or upward — without worrying about the size of the quantity.

Key Features:

Notation:

Usually written with a hat symbol (^) on top of a letter.

Examples: $\hat{i}$, $\hat{j}$, $\hat{k}$ are the standard unit vectors in 3D space.

Standard Unit Vectors in 3D:

These are like the basic arrows along each axis.

Why Are Unit Vectors Useful?

1. To show direction in problems.
2. To break big vectors into smaller parts (called components).
3. To write any vector easily using direction-based components.

Example:

Suppose a vector A has magnitude 5 and direction along x-axis.

Then,

> $A = 5\hat{i}$
This means:

Vector A has magnitude 5 units

Direction is along x-axis
If it was going diagonally in 2D:

> $A = 3\hat{i} + 4\hat{j}$

This means :
3 units along x , 4 units along y
To find direction: use the unit vector in that direction.
How to Find a Unit Vector of Any Vector:

If a vector A has magnitude |A|, then

> Unit vector = A / |A|

So you're dividing the vector by its own magnitude to make its length 1.

4. **What is a Resultant Vector?**

A resultant vector is the single vector that has the same effect as two or more vectors acting together.

Think of it like this:
If two or more forces (or velocities, displacements, etc.) act on a body, the resultant vector replaces them with one combined vector.

Example:

If you walk:
3 m east, then 4 m north

You didn’t just walk those two separately — your overall movement can be shown as one resultant displacement vector.

Finding the Resultant Vector:

A. When Vectors Are Along the Same Line (Straight Path):

Just add or subtract their magnitudes.

Same direction:
R = A + B

Opposite direction:
R = A - B (take the larger direction as positive)

B. When Vectors Are at an Angle (Usually 90°):

Use the Pythagoras Theorem:

> If two vectors A and B are at right angles,
Resultant $R = \sqrt{(A^2 + B^2)}$

And the direction (angle θ) of R is given by:

> $\tan \theta = B / A$

Vector Triangle Method (Triangle Law of Addition):

Place the tail of vector B at the head of vector A

The vector from the start of A to the end of B is the resultant vector R

Parallelogram Method (for non-90° angle):

If two vectors start from the same point and make an angle θ between them:

> $R = \sqrt{(A^2 + B^2 + 2AB \cos\theta)}$

This is used when the angle is not 90°.

- Key Points:

Feature	Description
What it shows	Combined effect of multiple vectors
Depends on	Magnitude and direction
Can be found	Geometry or Formula

Used for	Displacement ,velocity,force,etc.

Simple Real-Life Analogy:

Imagine rowing a boat:

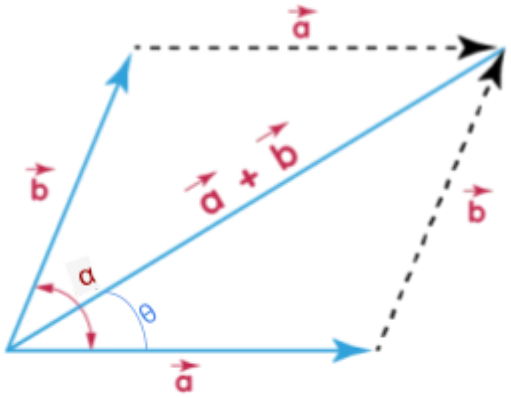
The river flows east at 3 m/s.

You row north at 4 m/s.

Your final motion (resultant) will be diagonally northeast, and its speed is:

> R = √(3² + 4²) = 5 m/s

5. What is the Parallelogram Law of Vectors?



The Parallelogram Law of Vector Addition is a rule to find the resultant when two vectors act at a point with an angle between them.

> If two vectors start from the same point, and make an angle θ between them, the resultant vector is represented by the diagonal of a parallelogram formed by the two vectors.

How It Works:

A. Draw both vectors from the same point (say, A and B).

B. Complete a parallelogram using A and B as adjacent sides.

C. The diagonal starting from the same point is the resultant vector R.

Formula:

> $R = \sqrt{(A^2 + B^2 + 2AB \cos\theta)}$

Where:

A and B are magnitudes of the two vectors.

θ is the angle between them.

R is the magnitude of the resultant vector.

Direction (Angle of Resultant):

The direction of R (angle α with vector A) is given by:

> $\tan \alpha = (B \sin\theta) / (A + B \cos\theta)$

Special Cases:

1. If θ = 0° (vectors in same direction):
R = A + B

2. If θ = 180° (opposite direction):
R = |A – B|

3. If θ = 90° (right angle):
$R = \sqrt{(A^2 + B^2)}$ → Pythagoras Theorem

Simple Example:

Suppose:

Vector A = 5 units

Vector B = 4 units

Angle between them = 60°

Then,

> $R = \sqrt{(5^2 + 4^2 + 2 \times 5 \times 4 \times \cos 60°)}$
$R = \sqrt{(25 + 16 + 40 \times 0.5)} = \sqrt{(25 + 16 + 20)} = \sqrt{61} \approx 7.8$ units

Where It Is Used:

To find net force when two forces act at an angle

To calculate total velocity or displacement in physics problems

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Diagram Suggestion:

Imagine drawing two arrows (A and B) from the same point, then completing a parallelogram. The diagonal from that point is the resultant.

6. What is the Triangle Law of Vectors?

The Triangle Law of Vector Addition is a rule to find the resultant of two vectors acting one after the other (like steps).

> If two vectors are represented as two sides of a triangle taken in order, then their resultant is the third side of the triangle taken in the opposite order.

How It Works:

a. Draw vector A.

b. From the tip (head) of A, draw vector B.

c. Now join the tail of A to the tip of B — this gives the resultant vector R.

This forms a triangle, and the third side is the resultant.

Formula (When Vectors Make Angle θ):
> $R = \sqrt{(A^2 + B^2 + 2AB \cos\theta)}$
(same as in parallelogram law)

Direction (Angle α with A):
> $\tan \alpha = (B \sin\theta) / (A + B \cos\theta)$

Special Case (90° angle):

If vectors A and B are at right angles, then:

> $R = \sqrt{(A^2 + B^2)}$
This is just the Pythagoras Theorem.

Real-Life Example:

If you:
Walk 4 m east
Then walk 3 m north

Your total movement = resultant vector = diagonal of triangle

> $R = \sqrt{(4^2 + 3^2)} = 5$ m (diagonal path)

Why It's Useful:
Used when:

Two forces or motions act one after another

Displacements or velocities are applied in sequence

7.

ভেক্টর উপাদান

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ইউনিট কী?

পদার্থবিজ্ঞানে, একটি ইউনিট হল একটি মানক পরিমাণ যা দৈর্ঘ্য, সময়, ভর, তাপমাত্রা ইত্যাদি মতো ভৌত বৈশিষ্ট্য পরিমাপ করতে ব্যবহৃত হয়। ইউনিট আমাদের সঠিকভাবে তুলনা ও পরিমাপ করতে সাহায্য করে।

স্কেলার ও ভেক্টর পরিমাণ

স্কেলার: শুধু মাত্রা (দিক নেই) – উদাহরণ: ভর, সময়, গতি, তাপমাত্রা

ভেক্টর: মাত্রা ও দিক – উদাহরণ: স্থানচ্যুতি (১০ মি পূর্বে), বেগ, বল

ভেক্টর কী?

একটি ভেক্টর হল একটি পরিমাণ যার মাত্রা ও দিক দুটোই থাকে।

মাত্রা মানে হচ্ছে “আকার” বা “পরিমাণ”।

দিক মানে হচ্ছে এটি কোন দিকে নির্দেশ করছে।

ভেক্টর চিত্রায়ন

ভেক্টর সাধারণত একটি তীরচিহ্ন দিয়ে দেখানো হয়।

তীরের দৈর্ঘ্য মাত্রা দেখায়।

তীরের দিক বোঝায় ভেক্টরের দিক।

সাধারণত A বা →A এর মতো করে লিখি।

ভেক্টর যোগ (ত্রিভুজ নিয়ম)

১. দ্বিতীয় ভেক্টরের শুরু প্রথমটির শেষে বসাও।

২. প্রথমটির শুরু থেকে দ্বিতীয়টির শেষ পর্যন্ত একটি নতুন ভেক্টর আঁকো – এটিই ফলাফল।

এটিকে ত্রিভুজ নিয়ম বলা হয়।

গুরুত্বপূর্ণ ভেক্টর অপারেশন

যোগ ও বিয়োগ – দুই ভেক্টরের যোগ বা পার্থক্য

স্কেলার গুণন – মাত্রা পরিবর্তন করে, দিক নয়

ইউনিট ভেক্টর – মাত্রা ১, কেবল দিক দেখায়

ইউনিট ভেক্টর কী?

একটি ইউনিট ভেক্টরের মাত্রা ১ এবং এটি কেবল দিক বোঝায়।

নোটেশন: $\hat{i}$, $\hat{j}$, $\hat{k}$ (x, y, z অক্ষ বরাবর)

উদাহরণ: $A = ৫\,\hat{i}$ বা $A = ৩\,\hat{i} + ৪\,\hat{j}$

যেকোনো ভেক্টরের ইউনিট ভেক্টর: $A / |A|$

ফলন ভেক্টর কী?

ফলন ভেক্টর হলো এমন একটি একক ভেক্টর যা একাধিক ভেক্টরের সম্মিলিত প্রভাবের সমান।

যেমন: ৩ মিটার পূর্বে হাঁটা, তারপর ৪ মিটার উত্তরে হাঁটা = একটি কর্ণ বরাবর চলা (ফলন)

ফলন নির্ণয়

একই রেখায়:

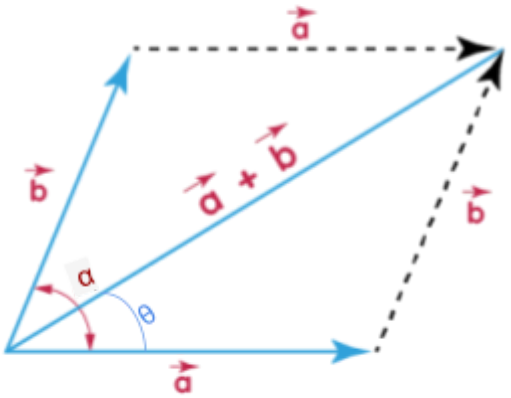
- একই দিকে → $R = A + B$

- বিপরীত দিকে → $R = A - B$

৯০° কোণে: $R = \sqrt{(A^2 + B^2)}$, $\theta = \tan^{-1}(B/A)$

যেকোনো কোণে: $R = \sqrt{(A^2 + B^2 + 2AB\cos\theta)}$

সামান্তরিক নিয়ম :-



দুটি ভেক্টর একটি বিন্দু থেকে শুরু হয়ে একটি কোণ গঠন করলে, তাদের ফলন ভেক্টরটি একটি সামান্তরিকর কর্ণ হয়।

দিকের কোণ (α): $\tan \alpha = (B \sin\theta) / (A + B \cos\theta)$

ত্রিভুজ নিয়ম

দুটি ভেক্টর একের পর এক প্রয়োগ করা হলে, তাদের ফলন ভেক্টর হয় তৃতীয় বাহু।

সূত্র: $R = \sqrt{(A^2 + B^2 + 2AB \cos\theta)}$, দিক: $\tan \alpha = (B \sin\theta) / (A + B \cos\theta)$