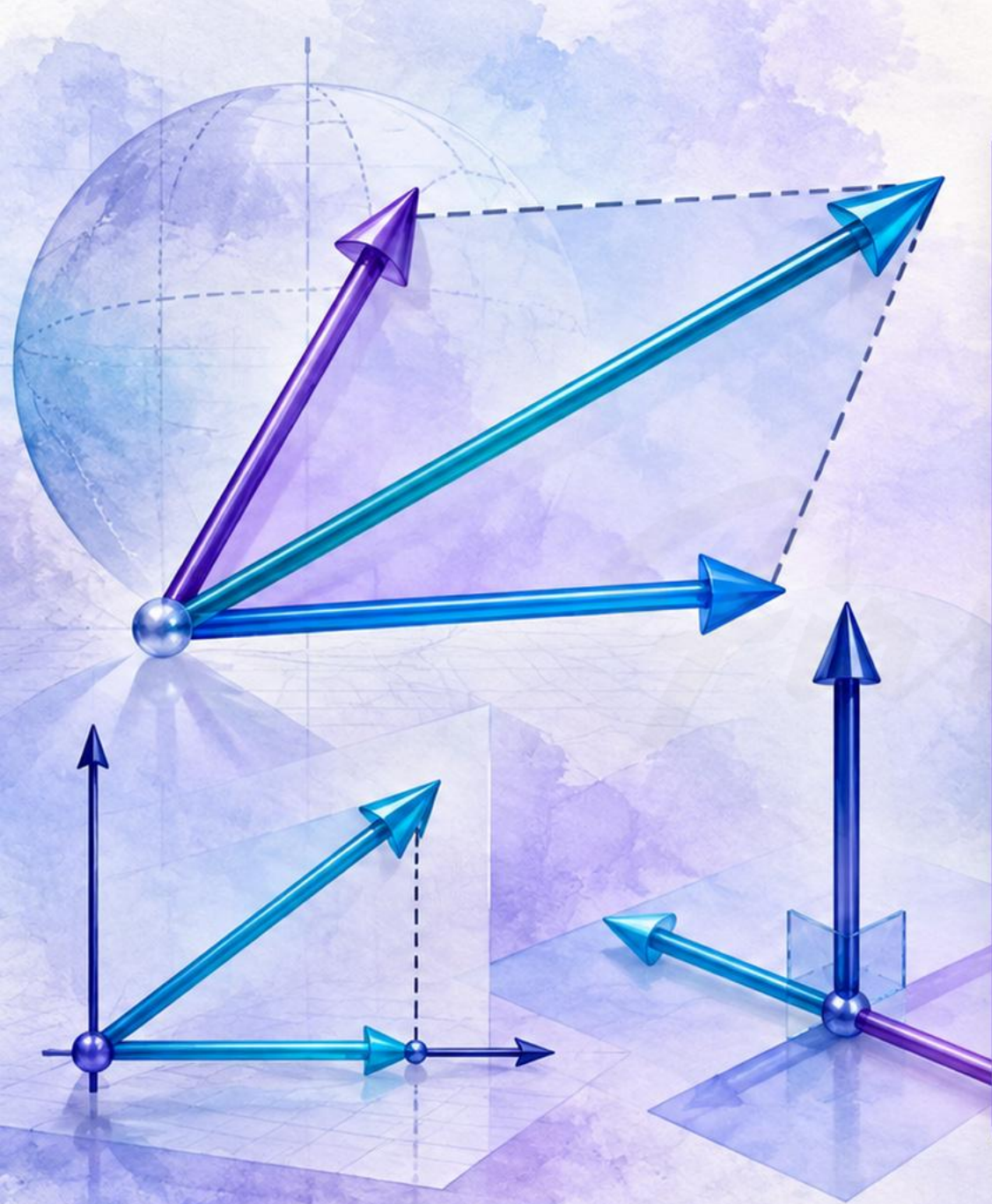




MATHEMATICS • CLASS 12

10

CHAPTER

Vector Algebra

CHAPTER NOTES

SCALARS AND VECTORS

Scalar quantities

- A scalar has magnitude only.
- Scalar examples: length, mass, time, distance, speed, area, volume, temperature and work.

Classifying the given quantities

<u>Given quantity</u>		<u>Quantity</u>	<u>Type</u>
5 seconds	→	time	scalar
1000 cm ³	→	volume	scalar
10 N	→	force	vector quantity

Vector quantities

- A vector has both magnitude and direction.
- Vector examples: displacement, velocity, acceleration, force, weight, momentum and electric field intensity.

<u>Given quantity</u>		<u>Quantity</u>	<u>Type</u>
30 km/h	→	speed	scalar
10 g/cm ³	→	density	scalar
20 m/s towards north	→	velocity	vector quantity

Direction is needed to describe a vector completely.

DIRECTED SEGMENTS AND POSITION VECTORS

Directed line segment



$$\vec{a} = \overrightarrow{AB}$$

$$|\vec{a}| = |\overrightarrow{AB}| = AB \geq 0$$

The arrow gives direction; the segment length gives magnitude.

Position vector

The vector from the origin to a point is its position vector.

$$P(x, y, z), \quad O(0, 0, 0)$$

$$\vec{r} = \overrightarrow{OP}$$

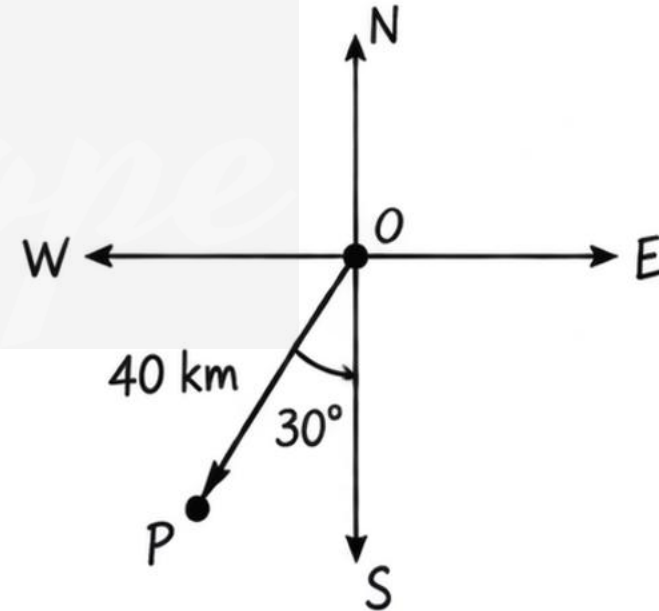
$$|\vec{r}| = \sqrt{x^2 + y^2 + z^2}$$

Displacement

A person moves south-west of the starting point.

$$|\overrightarrow{OP}| = 40 \text{ km}$$

direction = 30° west of south



This directed segment represents the person's displacement.

DIRECTION ANGLES AND DIRECTION COSINES

Direction angles

A nonzero vector makes direction angles with the positive coordinate axes.

α with positive x -axis

β with positive y -axis

γ with positive z -axis

Their cosines are called direction cosines.

$$l = \cos \alpha, \quad m = \cos \beta, \quad n = \cos \gamma$$

Direction ratios

Any three numbers proportional to the direction cosines are direction ratios.

$$a : b : c = l : m : n$$

$$(l, m, n) = \frac{(a, b, c)}{\sqrt{a^2 + b^2 + c^2}} \quad \text{when the ratios follow the chosen direction.}$$

Reversing the direction reverses all three direction cosines.

Coordinate form

$$\vec{r} = \overrightarrow{OP}, \quad P(x, y, z), \quad r = |\vec{r}| > 0$$

$$l = \frac{x}{r}, \quad m = \frac{y}{r}, \quad n = \frac{z}{r}$$

$$x = lr, \quad y = mr, \quad z = nr$$

$$l^2 + m^2 + n^2 = \frac{x^2 + y^2 + z^2}{r^2} = 1$$

$$\hat{a} = l\hat{i} + m\hat{j} + n\hat{k}$$

The zero vector has no fixed direction; its direction angles and direction cosines are not defined.

TYPES OF VECTORS

Zero vector

Initial and terminal points coincide; magnitude is zero; no fixed direction.

$$\overrightarrow{AA} = \vec{0}$$

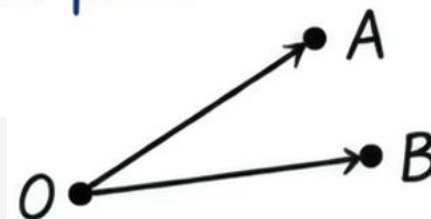
Unit vector

Magnitude is one.

$$|\hat{a}| = 1$$

Coinitial vectors

Vectors have the same initial point.



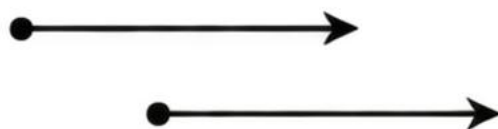
Collinear vectors

Vectors lie on the same line or parallel lines; directions may be the same or opposite.



Equal vectors

Same magnitude and same direction, even at different starting points.



Negative vector

Same magnitude but opposite direction.

$$\overrightarrow{BA} = -\overrightarrow{AB}$$
A diagram showing two parallel horizontal vectors. The top vector points to the right and is labeled with the vector symbol a with a right arrow above it. The bottom vector points to the left and is labeled with the vector symbol a with a right arrow above it and a minus sign in front, representing the negative of the first vector.

In this chapter, vectors are free vectors: parallel translation does not change them.



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