# CBSE Class 12 Mathematics
## Chapter-10
## Vector Algebra

- **Vector**: A quantity that has magnitude as well as direction is called vector.
- **Zero Vector**: A vector whose intial and terminal point coincide is called a zero vector or a null vector. It is denoted as $\overrightarrow{O}$.
- **Co-initial vectors**: Two or more vectors having the same initial points are called co-initial vectors.
- **Collinear vectors**: Two or more vectors are said to be collinear if they are parallel to the same line, irrespective of their magnitudes and directions.
- **Equal vectors**: Two vectors are said to be equal, if they have the same magnitude and direction regardless of the position of their initial points.
- **Negative of a vector**: A vector whose magnitude is the same as that of a given vector, but direction is opposite to that of it, is called negative of the given vector.
- Position vector of a point P (x, y) is given as $\overrightarrow{OP}\left(=\overrightarrow{r}\right)=x\hat{i}+y\hat{j}+z\hat{k}$ and its magnitude by $\sqrt{x^2+y^2+z^2}$
- The scalar components of a vector are its direction ratios, and represent its projections along the respective axes.
- The magnitude (r), direction ratios (a, b, c) and direction cosines (l, m, n) of any vector are related as: $l=\frac{a}{r}, m=\frac{b}{r}, n=\frac{c}{r}$
- The vector sum of the three sides of a triangle taken in order is $\overrightarrow{O}$
- The vector sum of two conidial vectors is given by the diagonal of the parallelogram whose adjacent sides are the given vectors.
- The multiplication of a given vector by a scalar λ, changes the magnitude of the vector by the multiple $|\lambda|$, and keeps the direction same (or makes it opposite) according as the value of λ is positive (or negative).
- For a given vector $\overrightarrow{a}$, the vector $\widehat{a}=\frac{\overrightarrow{a}}{\left|\overrightarrow{a}\right|}$ gives the unit vector in the direction of $\overrightarrow{a}$
- The position vector of a point R dividing a line segment joining the points P and Q

whose position vectors are $\overrightarrow{a}$ and $\overrightarrow{b}$ respectively, in the ratio $m:n$

(i) internally, is given by $\frac{n\overrightarrow{a}+m\overrightarrow{b}}{m+n}$

(ii) externally, is given by $\frac{m\overrightarrow{b}-n\overrightarrow{a}}{m-n}$

- The scalar product of two given vectors $\overrightarrow{a}$ and $\overrightarrow{b}$ having angle θ between them is defined as $\overrightarrow{a}.\overrightarrow{b}=\left|\overrightarrow{a}\right|\left|\overrightarrow{b}\right|\cos\theta$

  Also, when $\overrightarrow{a}.\overrightarrow{b}$ is given, the angle '$\theta$' between the vectors $\overrightarrow{a}$ and $\overrightarrow{b}$ may be determined by $\cos\theta=\frac{\overrightarrow{a}.\overrightarrow{b}}{\left|\overrightarrow{a}\right|\left|\overrightarrow{b}\right|}$

- If $\theta$ is the angle between two vector $\overrightarrow{a}$ and $\overrightarrow{b}$, then their cross product is given as $\overrightarrow{a}\times\overrightarrow{b}=\left|\overrightarrow{a}\right|\left|\overrightarrow{b}\right|\sin\theta.\widehat{n}$ where $\hat{n}$ is a unit vector perpendicular to the plane containing $\overrightarrow{a}$ and $\overrightarrow{b}$. Such that $\overrightarrow{a},\overrightarrow{b},\widehat{n}$ form right handed system of coordinate axes.

- If we have two vectors $\overrightarrow{a}$ and $\overrightarrow{b}$ given in component form as

  $\overrightarrow{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$ and $\overrightarrow{b}=b_1\hat{i}+b_2\hat{j}+b_3\hat{k}$ and $\lambda$ be any scalar, then,

  $\overrightarrow{a}+\overrightarrow{b}=(a_1+b_1)\hat{i}+(a_2+b_2)\hat{j}+(a_3+b_3)\hat{k}$

  $\lambda\overrightarrow{a}=(\lambda a_1)\hat{i}+(\lambda a_2)\hat{j}+(\lambda a_3)\hat{k}$

  $\overrightarrow{a}.\overrightarrow{b}=a_1b_1+a_2b_2+a_3b_3$

  and $\overline{a}\times\overline{b}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ a_1 & b_1 & c_1\\ a_2 & b_2 & c_2\end{vmatrix}$

  **Parallelogram Law of vector addition**: If two vectors $\overrightarrow{a}$ and $\overrightarrow{b}$ are represented by adjacent sides of a parallelogram in magnitude and direction, then their sum $\overrightarrow{a}+\overrightarrow{b}$ is represented in magnitude and direction by the diagonal of the parallelogram through their common initial point. This is known as Parallelogram Law of vector addition.