# IMPORTANT JEE-NEET FORMULAS

## Vector's Formula's

- **Position Vector Of a Point:** If $\vec{a}$ and $\vec{b}$ are positive vectors of two points A and B, then
$$\overrightarrow{AB} = \vec{b} - \vec{a}$$

  i. **Distance Formula:** Distance between the two points $A(\vec{a})$ and $B(\vec{b})$ is
  $$AB = |\vec{a} - \vec{b}|.$$

  ii. **Section Formula:**
  $\vec{r} = \frac{n\vec{a}+m\vec{b}}{m+n}$, Midpoint of $AB = \frac{\vec{a}+\vec{b}}{2}$

- **Scalar Product of Two vectors:** $\vec{a}.\vec{b} = |\vec{a}||\vec{b}| \cos\theta$ , where $|\vec{a}|, |\vec{b}|$ are magnitude of $\vec{a}$ and $\vec{b}$ respectively and $\theta$ is the angle between $\vec{a}$ and $\vec{b}$

  i. $i.i = j.j = k.k = 1;\ i.j = j.k = k.i = 0$ , projection of $\vec{a}$ on $\vec{b} = \frac{\vec{a}.\vec{b}}{|\vec{b}|}$.

  ii. If $\vec{a} = a_1 i + a_2 j + a_3 k$ & $\vec{b} = b_1 i + b_2 j + b_3 k$ then $\vec{a}.\vec{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$.

  iii. The angle $\emptyset$ between $\vec{a}$ & $\vec{b}$ is given by $\cos\emptyset = \frac{\vec{a}.\vec{b}}{|\vec{a}||\vec{b}|}, 0 \le \emptyset \le \pi$.

  iv. $\vec{a}.\vec{b} = 0 \leftrightarrow \vec{a}$ Perpendicular to $\vec{b}$ $(\vec{a} \neq 0, \vec{b} \neq 0)$.

- **Vector Product of Two vectors:**

  i. If $\vec{a}$ & $\vec{b}$ are two vectors and $\theta$ is the angle between them then
  $\vec{a} \times \vec{b} = |\vec{a}||\vec{b}| \sin\theta\, \vec{n}$ , where $\vec{n}$ is the unit vector perpendicular to both $\vec{a}$ & $\vec{b}$ such that $\vec{a}, \vec{b}$&$\vec{n}$ forms a right handed screw system.

  ii. Geometrically $|\vec{a} \times \vec{b}|$ =area of the parallelogram whose two adjacents sides are represented by $\vec{a}$ & $\vec{b}$.

  iii. $\hat{\imath} \times \hat{\imath} = \hat{\jmath} \times \hat{\jmath} = \hat{k} \times \hat{k} = 0;\ \hat{\imath} \times \hat{\jmath} = \hat{k},\ \hat{\jmath} \times \hat{k} = \hat{\imath},\ \hat{k} \times \hat{\imath} = \hat{\jmath}$

  iv. If $\vec{a} = a_1\hat{\imath} + a_2\hat{\jmath} + a_3\hat{k}$ & $\vec{b} = b_1\hat{\imath} + b_2\hat{\jmath} + b_3\hat{k}$ then $\vec{a} \times \vec{b} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$

  v. $\vec{a} \times \vec{b} = \vec{o} \leftrightarrow \vec{a}$ and $\vec{b}$ are parallel (collinear) $(\vec{a} \neq 0, \vec{b} \neq 0)$ i.e. $\vec{a} = K\vec{b}$ where K is a scalar.

  vi. Unit vector perpendicular to the plane of $\vec{a}$ & $\vec{b}$ is $\hat{n} = \pm\frac{\vec{a} \times \vec{b}}{|\vec{a} \times \vec{b}|}$.

vii. If $\vec{a}, \vec{b} \& \vec{c}$ are the position vectors of 3 points A, B & C then the vector area of triangle $ABC = \frac{1}{2}[\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}]$. The points A,B & C are collinear if $\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a} = \vec{0}$

viii. Area of any quadrilateral whose diagonal vectors are $\overrightarrow{d_1}$ & $\overrightarrow{d_2}$ is given by $\frac{1}{2}|\overrightarrow{d_1} \times \overrightarrow{d_2}|$.

ix. Lagrange's Identity: $(\vec{a} \times \vec{b})^2 = |\vec{a}|^2|\vec{b}|^2 - (\vec{a}.\vec{b})^2 = \begin{vmatrix} \vec{a}.\vec{a} & \vec{a}.\vec{b} \\ \vec{a}.\vec{b} & \vec{b}.\vec{b} \end{vmatrix}$

- **Scalar Triple Product:**

  i. The scalar triple product of three vectors $\vec{a}, \vec{b} \& \vec{c}$ is defined as:

$$\vec{a} \times \vec{b}.\vec{c} = |\vec{a}||\vec{b}||\vec{c}| \sin\theta \cos\emptyset$$

  ii. Volume of tetrahedron $V = [\vec{a}.\vec{b}.\vec{c}]$

  iii. In a scalar triple product the position of dot and cross can be interchanged i.e.
  $\vec{a}.(\vec{b} \times \vec{c}) = (\vec{a} \times \vec{b}).\vec{c}$ Or $[\vec{a}\,\vec{b}\,\vec{c}] = [\vec{b}\,\vec{c}\,\vec{a}] = [\vec{c}\,\vec{a}\,\vec{b}]$
  $\vec{a}.(\vec{b} \times \vec{c}) = -\vec{a}.(\vec{c} \times \vec{b})$ i.e. $[\vec{a}\,\vec{b}\,\vec{c}] = -[\vec{a}\,\vec{c}\,\vec{b}]$

  iv. If $\vec{a} = a_1 i + a_2 j + a_3 k;\ \vec{b} = b_1 i + b_2 j + b_3 k \ \& \ \vec{c} = c_1 i + c_2 j + c_3 k$ then
  $[\vec{a}.\vec{b}.\vec{c}] = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$

  v. If $\vec{a}, \vec{b}, \vec{c}$ are coplanar$\leftrightarrow$ $[\vec{a}\,\vec{b}\,\vec{c}] = 0$.

  vi. Volume of tetrahedron OABC with O as origin & A($\vec{a}$), B($\vec{b}$) and C($\vec{c}$) be the vertices $= \left|\frac{1}{6}[\vec{a}\,\vec{b}\,\vec{c}]\right|$.

  vii. The position vector of the centroid of a tetrahedron if the pv's of its vertices are $\vec{a}, \vec{b}, \vec{c}$ & $\vec{d}$ are given by $\frac{1}{4}[\vec{a} + \vec{b} + \vec{c} + \vec{d}]$.

- **Vector Triple Product:**

  $\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a}.\vec{c})\vec{b} - (\vec{a}.\vec{b})\vec{c},\ (\vec{a} \times \vec{b}) \times \vec{c} = (\vec{a}.\vec{c})\vec{b} - (\vec{b}.\vec{c})\vec{a}$

  **In general:** $(\vec{a} \times \vec{b}) \times \vec{c} \neq \vec{a} \times (\vec{b} \times \vec{c})$