---

# SYSTEM OF PARTICLES AND ROTATIONAL MOTION

## VECTOR PRODUCT OF TWO VECTORS

---

### Vector Product of Two Vectors and their properties

The cross product, area product or the vector product of two vectors is a binary operation on two vectors in three-dimensional spaces. It is denoted by ×. The cross product of two vectors is a vector.

Let us consider two vectors denoted as. Let the product (also a vector) of these two vectors be denoted as.

### Magnitude of the vector product

The magnitude of the vector product is given as,

$$|\bar{c}| = |a||b|\sin \theta$$

Where a and b are the magnitudes of the vector and θ is the angle between these two vectors. From the figure, we can see that there are two angles between any two vectors, that is, θ and (360° – θ). In this rule, we always consider the smaller angle that is less than 180°.

### Direction of the vector product
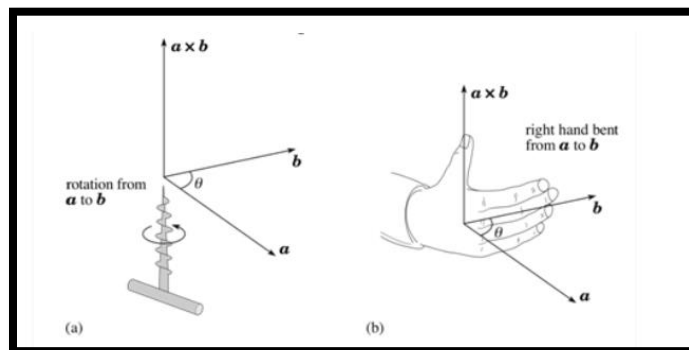
The right-hand thumb rule is used in which we curl up the fingers of right hand around a line perpendicular to the plane of the vectors a and b and the curl the fingers in the direction from a to b, then the stretched thumb points in the direction of c.

## Commutative property

Unlike the scalar product, cross product of two vectors is not commutative in nature.

Mathematically, for scalar products

$$a.b = b.a$$

But for vector products

$$a \times b \neq b \times a$$

As we know, the magnitude of both the cross products $a \times b$ and $b \times a$ is the same and is given by $ab\sin\theta$; but the curling of the right-hand fingers in case of $a \times b$ is from a to b, whereas in case of ($b \times a$) it is from b to a, as per which, the two vectors are in opposite directions.

Mathematically,

$$a \times b = -b \times a$$

Distributive property

Like the scalar product, vector product of two vectors is also distributive with respect to vector addition. Mathematically,

$$a \times (b + c) = a \times b + a \times c$$

In order to deal with the vector product of any two vectors, we need to know the vector product of two elementary vectors.

$$\bar{a} \times \bar{a} = 0, \text{ as } |a||a|\sin 0° = 0$$

Similarly, for the unit vectors following results hold good,

$$\overleftrightarrow{i} \times \hat{i} = \hat{j} \times \hat{j} = \overleftrightarrow{k} \times \overleftrightarrow{k} = 0 \text{ and } \vec{i} \times \hat{j} = \overleftrightarrow{k}$$