

PRODUCT OF VECTORS

Part IV

Scalar or Dot Product

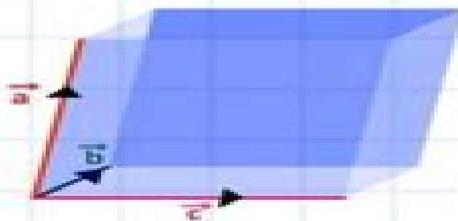


$$\vec{a} \cdot \vec{b} = |\vec{a}| |\vec{b}| \cos \theta \quad \text{Or} \quad \vec{a} \cdot \vec{b} = a b \cos \theta$$



- Dot product of \vec{a} and \vec{b} is the projection of \vec{a} over \vec{b} .

Scalar Triple Product



Scalar triple product represents the volume of a parallelepiped

SCALAR TRIPLE PRODUCT

$$\vec{a} \cdot (\vec{b} \times \vec{c}) = [\vec{a} \ \vec{b} \ \vec{c}] \quad \vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$$

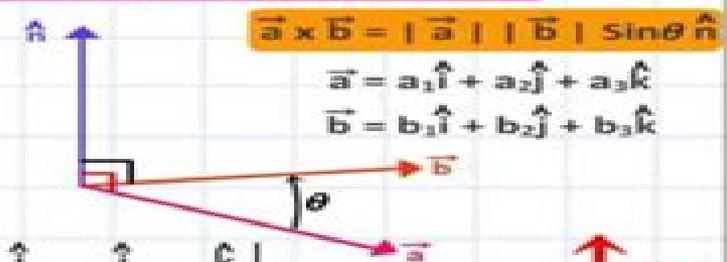
$$\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k} \quad \vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$$

$$\vec{a} \cdot (\vec{b} \times \vec{c}) = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = [\vec{a} \ \vec{b} \ \vec{c}]$$

NOTE

- (i) \vec{a} , \vec{b} & \vec{c} are Coplanar iff $[\vec{a} \ \vec{b} \ \vec{c}] = 0$

Vector or Cross Product



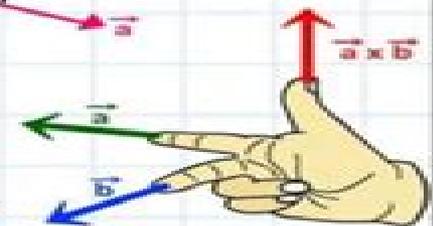
$$\vec{a} \times \vec{b} = |\vec{a}| |\vec{b}| \sin \theta \hat{n}$$

$$\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$$

$$\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$$

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

- Direction of resultant vector can be found using **Right Hand Rule**



Vector Triple Product



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

NOTE

- (i) $(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d}) = \vec{a} \cdot \vec{b} \times (\vec{c} \times \vec{d})$
 $= \vec{a} \cdot \{(\vec{b} \cdot \vec{d}) \vec{c} - (\vec{b} \cdot \vec{c}) \vec{d}\}$
 $= (\vec{a} \cdot \vec{c})(\vec{b} \cdot \vec{d}) - (\vec{a} \cdot \vec{d})(\vec{b} \cdot \vec{c})$
- (ii) $(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d}) = [\vec{a} \ \vec{c} \ \vec{d}] \vec{b} - [\vec{b} \ \vec{c} \ \vec{d}] \vec{a}$
 Or $= [\vec{a} \ \vec{b} \ \vec{d}] \vec{c} - [\vec{a} \ \vec{b} \ \vec{c}] \vec{d}$

Vectors And Their Applications

D Keegan

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