$where, \hat{\imath}$ & $\hat{\jmath}$ $are\ the\ unit\ vectors\ along\ positive\ X - axis$ & $Y - axis\ respectively.$

$|\overrightarrow{OP}| = |\vec{r}| = \sqrt{x^2 + y^2}$.

$x\hat{\imath}$ & $y\hat{\jmath} = Vector\ components\ along\ X - axis$ & $Y - axis$.

x & $y =$ $Scalar\ components\ along\ X - axis$ & $Y - axis$.

(6) **3-Dimensional (3-D)**

$If\ P(x, y, z)\ be\ a\ point\ in\ 3 - D\ plane, then\ the\ position\ vector\ of\ P\ w.r.t. origin\ O\ (\vec{r})\ is$

$\overrightarrow{OP} = \vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$.

$where, \hat{\imath}, \hat{\jmath}$ & $\hat{k}$ $are\ the\ unit\ vectors\ along\ positive\ X - axis, Y - axis$ & $Z - axis$ $respectively.$

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

$x\hat{\imath}, y\hat{\jmath}$ & $z\hat{k} = Vector\ components\ along\ X - axis, Y - axis$ & $Z - axis$.

x, y & $z =$ $Scalar\ components\ along\ X - axis, Y - axis$ & $Z - axis$.

(7) **Direction Ratios & Direction Cosines of a Vector**

$Consider\ the\ vector\ \vec{r} = a\hat{\imath} + b\hat{\jmath} + c\hat{k}$

$(i) Then\ direction\ ratios\ of\ \vec{r}\ are\ a, b, c.$

$(ii) The\ direction\ cosines\ of\ \vec{r}\ are\ given\ by$

$$l = \frac{a}{\sqrt{a^2 + b^2 + c^2}}\ ;\ m = \frac{b}{\sqrt{a^2 + b^2 + c^2}};\ n = \frac{c}{\sqrt{a^2 + b^2 + c^2}}$$

$(iii) l^2 + m^2 + n^2 = 1.$

$(iv) If\ A(x_1, y_1, z_1)\ and\ B(x_2, y_2, z_2)\ be\ any\ two\ points\ in\ space\ then\ direction$ $ratios\ of\ \overrightarrow{AB}\ are\ (x_2 - x_1), (y_2 - y_1), (z_2 - z_1)\ and\ direction\ cosines\ of\ \overrightarrow{AB}\ are$

$$\frac{(x_2 - x_1)}{r}, \frac{(y_2 - y_1)}{r}, \frac{(z_2 - z_1)}{r}\ \ where\ r = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}.$$

(8) **Scalar product / Dot product of vectors**

(i) $The\ scalar\ product\ of\ two\ vectors\ \vec{a}$ & $\vec{b}, which\ meets\ in\ a\ point\ is\ given\ by$

$\vec{a}.\vec{b} = |\vec{a}||\vec{b}|\cos\theta$

$where\ \theta\ is\ the\ angle\ between\ these\ vectors.$

(ii) $\hat{\imath}.\hat{\imath} = \hat{\jmath}.\hat{\jmath} = \hat{k}.\hat{k} = 1.$

(iii) $\hat{\imath}.\hat{\jmath} = \hat{\jmath}.\hat{k} = \hat{k}.\hat{\imath} = 0.$

(iv) $\lambda(a\hat{\imath} + b\hat{\jmath}) = \lambda a\hat{\imath} + \lambda b\hat{\jmath}.$

(v) $If\ \vec{a} = \vec{0}\ or\ \vec{a} = \vec{0}, we\ define\ \vec{a}.\vec{b} = 0.$

(vi) $If\ \vec{a}\ and\ \vec{b}\ are\ like\ (collinear)\ vectors, we\ have\ \theta = 0;\ \vec{a}.\vec{b} = ab\cos\theta = ab.$

(vii) $If\ \vec{a}\ and\ \vec{b}\ are\ unlike\ vectors, we\ have\ \theta = \pi;\ \vec{a}.\vec{b} = ab\cos\theta = -ab.$