# Vector Differentiation

## Vector function

If vector function is like a normal function of any variable.

like :

$\vec{r} = \vec{r}(t)$.

$\vec{r}$ is a function of scalar $t$.

And when $\vec{r}$ move along a curved path then position vector $f(t)$ of $\vec{r}$ is given by :

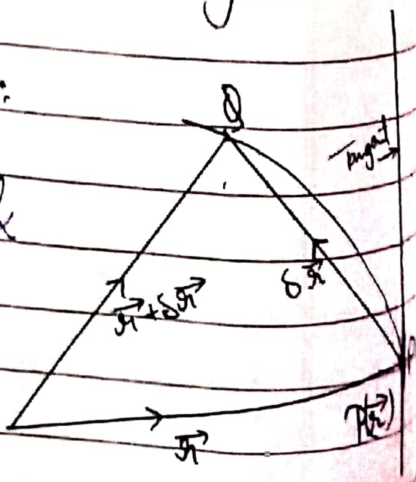
$$\vec{f}(t) = f_1(t)\hat{i} + f_2(t)\hat{j} + f_3(t)\hat{k}$$

where;

$f_1(t)$ is a component along $x$-axis
$f_2(t)$ is a component along $y$-axis
$f_3(t)$ is a component along $z$-axis

## Vector Differentiation :

Let O be the origin & P is the initial position of a moving particle at time '$t$'.



and Q is the position of the particle after "$\delta t$" time when it travel a distance of $\delta \vec{r}$

Thus,
we can write position vectors of as :

$$\vec{OP} = \vec{r}$$

$$\vec{OQ} = \vec{r} + \delta\vec{r}$$

$$\vec{PQ} = OQ - OP$$
$$= (\vec{r} + \delta\vec{r}) - \vec{r}$$
$$= \delta\vec{r}$$

$\frac{\delta\vec{r}}{\delta t}$ is a vector, as $\delta t \to 0$, $P \to Q$

and the chord PQ becomes a tangent at P.

We define, $\frac{d\vec{r}}{dt} = \lim_{t \to 0} \frac{\partial\vec{r}}{\partial t}$

$\frac{\partial\vec{r}}{\partial t}$ is a directional vector of the tangent at P, which is differential (derivative) of r (w.r.t) with respect to 't'. It gives velocity at P.

"Rough 'n' Fair"

also $\frac{d^2 r}{dt^2}$ ~~are~~ is second order derivative of $\vec{r}$. It gives acceleration of particle at ~~P~~ P.