KINEMATICS

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Motion: Motion is the change in position of an object with time.

The branch of Physics deals with motion is known as mechanics; There are basically two branches of mechanics

i) Static ii) Kinetics

i) Static motion:- Deals with object at rest

ii) Kinetic motion:- Deals with actual motion.

it is further devided into two parts

(a) kinematics (b) Dynamics

(a) kinematics:- In this branch we describe various motions without discussing their cause. which are Distance, Displacement, Speed, Velocity & Acceleration.

(b) Dynamics:- In this branch we describe motions along with its cause, which is force or torque parameters ~~discuss~~. are momentum, force, energy power etc. with addition to parameters of kinematics.

for study of motion must know About frame of refernce:-

The co-ordinates of object to describe the position of object along with a clock constitutes a frame of reference.

* Various Parameters In Kinematics

1) Distance:- It is the actual Path travel by the object During its motion. it has only magnitude i.e. scalar quantity.

2) Displacement:- The shortest length of the line joining initial position & final position of obje is called Displacement.

It has magnitude as well as direction i.e. Vector Quantity.

3) Speed:- Rate of change of distance with respe to time is known as Speed.

$$\therefore \text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{ds}{dt}$$

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

→ Its SI Unit is m/s

→ It is scalar quantity.

④ Velocity:- Rate of change of displacement with respect to time is known as velocity.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}} = \frac{\vec{r_2} - \vec{r_1}}{t_2 - t_1}$$

→ Its SI unit m/s

→ It is Vector quantity.

→ Dimension $[M^0 L^1 T^{-1}]$

⑤ Acceleration:- The rate of change of velocity with respect to time is called acceleration.

$$\vec{a} = \frac{d\vec{v}}{dt}$$

→ Its SI Unit is m/s^2
→ It is a Veeter quantity
→ Dimension $[M\ L^1\ T^{-2}]$

* Motion with constant Accelaration:-

i.e. $\frac{dv}{dt} = \text{const.}$

for problems related to motion of object with constant acceleration we use equation of motions

Ⓘ $V = u + at$
Ⓘⓘ $v^2 = u^2 + 2as$
Ⓘⓘⓘ $s = ut + \frac{1}{2}at^2$

where v- final Velocity
u- initial velocity
a- Accelaration
s- Displacement of object
t- time

* Equation of motions for freely falling Body.

$V = u - gt$
$H = ut + \frac{1}{2}gt^2$
$v^2 = u^2 - 2gH$

Motion in a plane:- As plane is 2-D system we have to consider two component for every parameter i.e. along x-dirn & Y-direction.

for that Equation of motion are

(I) Along - x-axis

(II) Along - Y-axis

(I) Along x-axis

$$V_x = u_x + a_x t \quad , \quad x = u_x t + \frac{1}{2} a_x t^2 \quad , \quad V_x^2 = u_x^2 + 2a_x x$$

(II) Along Y-axis

$$V_y = u_y + a_y t \quad , \quad y = u_y t + \frac{1}{2} a_y t^2 \quad , \quad V_y^2 = u_y^2 + 2a_y y$$

* ~~Projectile Motion~~ :-

* Scalar & Vectors :-

Physical quantities which has only magnitude is called scalars. Eg. mass, Distance, time, temp. density etc.

Vectors :- physical quantities which need magnitude as well as direction for complete description are called vectors.

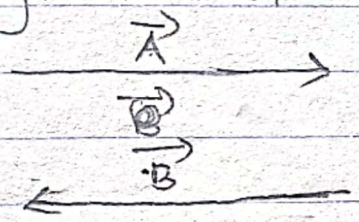
Eg. Displacement, velocity, force etc.

There are few types of vectors

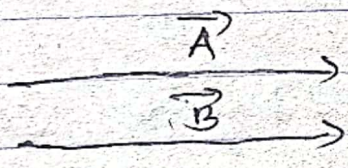
(1) Zero Vector (Null Vector) - A vector having zero magnitude with direction is called Null vector

(b) Resultant Vector:- The resultant of two or more vectors is that single vector, which ~~has~~ produces the same effect as by all the vectors together

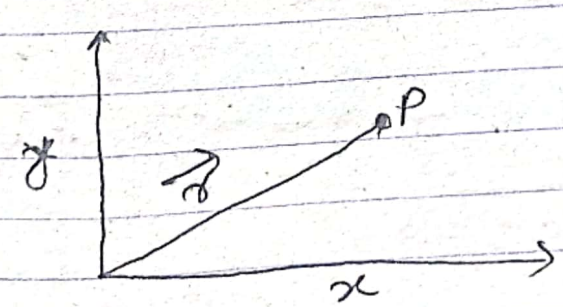
(c) Negative Vector(opposite vector) :- A vector which has same magnitude but opposite direction of the given vector.



(d) Equal Vector:- The two vector are said to be equal iff they have same magnitude & direction.



(e) Position Vector:- The vector which gives position of a particle ~~with a origin~~ with respect to origin is called the position vector.



(f) Unit Vector:- A vector having unit magnitude is called unit vector

* Vector operations:-

① Multiplication of vector by scalar

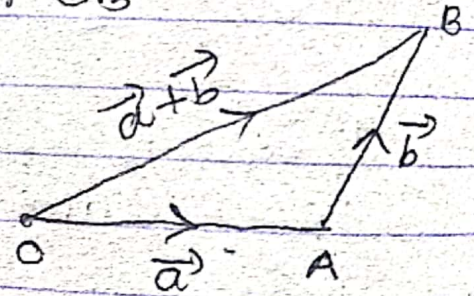
Let $\vec{p}$ is a vector multiplied by scalar α then resultant vector

$$\vec{Q} = \alpha \vec{p}$$

$\therefore \vec{Q}$ is vector of same direction & magnitude is α times of $\vec{p}$.

② Addition of vectors:-

Let $\vec{a}$ and $\vec{b}$ two given vectors $\vec{OA} = \vec{a}$ & $\vec{AB} = \vec{B}$ then vector $\vec{OB}$ is called sum of $\vec{a}$ and $\vec{b}$



$$\vec{OA} + \vec{AB} = \vec{OB}$$
$$\vec{a} + \vec{b} = \vec{OB}$$

Properties of vector Addition & substraction

① Vector Addition is commutative

$$\vec{a} + \vec{b} = \vec{b} + \vec{a}$$

② Vector Addition is Associative

$$(\vec{A} + \vec{B}) + \vec{C} = \vec{A} + (\vec{B} + \vec{C})$$

Magnitude of Resultant Vector of $\vec{A}$ & $\vec{B}$

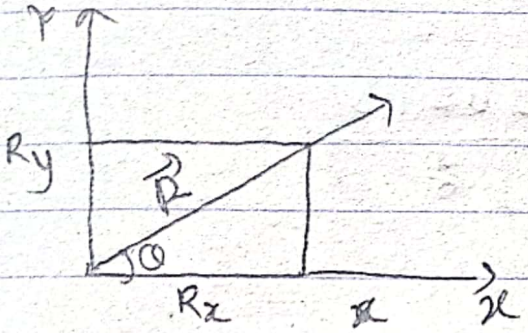
$$\vec{R} = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

Angle between vector A & $\vec{B}$

$$\alpha = \tan^{-1}\left(\frac{A\sin\theta}{A + B\cos\theta}\right)$$

* Resolution of vectors:-

The process of splitting of a given vector into its components is called resolution of the vector.



$$\vec{R} = \sqrt{Rx^2 + Ry^2}$$

$\therefore \vec{R}$ has two components

① x- Component

$Rx = R\cos\theta$

② y- Component

$Ry = R\sin\theta$

* Multiplication of vectors:-

① Scalar product:-

The scalar product of two vector is written as

$\vec{P}.\vec{Q} = PQ\cos\theta$, θ- Angle bet^n P & Q

Here $\hat{i}.\hat{j} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$ else $i.j = j.k = k.j = 0$

②

② Vector product:-

$\vec{P} \times \vec{Q} = |P||Q|\sin\theta$

properties :- ① $\vec{P}\times\vec{Q} \neq \vec{Q}\times\vec{P}$ ② $\vec{P}\times\vec{Q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ Px & Py & Pz \\ Qx & Qy & Qz \end{vmatrix}$

③ Area of parallelogram $= |\vec{P}\times\vec{Q}|$

* Projectile Motion :- Any object in flight after be thrown with some velocity is called a projectile & its motion is called projectile motion.

Important Formulas

① Time of flight $= \frac{2u\sin\theta}{g}$.

② Range $= \frac{u^2\sin 2\theta}{g}$

③ Maximum Height $(H) = \frac{u^2\sin^2\theta}{2g}$.