BRAIN MAP

MOTION IN A PLANE

CLASS XI

VECTOR

Physical quantities having both magnitude and direction

Addition of Vectors

Triangle Law

If two vectors are represented by two sides of a triangle in same order, the resultant will be the third side but in opposite order. $\vec{C} = \vec{A} + \vec{B}$

Parallelogram Law

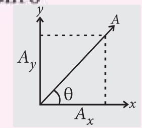
For two coinitial vectors represented by the two adjacent side of a parallelogram, the diagonal of the parallelogram so formed will be the resultant. $R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

Resolution of Vector

Horizontal component of $\vec{A}$, $A_x = A\cos\theta$

Vertical component of $\vec{A}$, $A_y = A\sin\theta$

$A = \sqrt{A_x^2 + A_y^2}$, $\tan\theta = \left(\frac{A_y}{A_x}\right)$



Multiplication by a Scalar Quantity

Multiplication of a vector by a scalar ϕ changes its magnitude by a factor of ϕ.

KINEMATICS IN TWO DIMENSIONS

Kinematic Equations in 2-Dimensions

- $\vec{v} = \vec{u} + \vec{a}t$
  - $v_x = u_x + a_x t$ (along x-axis)
  - $v_y = u_y + a_y t$ (along y-axis)
- $\vec{r} = \vec{r}_0 + \vec{u}_0 t + (1/2)\vec{a}t^2$
  - $x = x_0 + u_x t + (1/2)a_x t^2$ (along x-axis)
  - $y = y_0 + u_y t + (1/2)a_y t^2$ (along y-axis)

Relative Velocity

According to vector law of addition

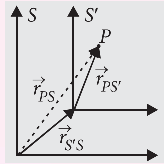
$\vec{r}_{PS} = \vec{r}_{PS'} + \vec{r}_{S'S}$

$\frac{d\vec{r}_{PS}}{dt} = \frac{d\vec{r}_{PS'}}{dt} + \frac{d\vec{r}_{S'S}}{dt}$

So, $\vec{v}_{PS} = \vec{v}_{PS'} + \vec{v}_{S'S}$

i.e., $\vec{v}_{actual} = \vec{v}_{relative} + \vec{v}_{reference}$

$\vec{v}_{relative} = \vec{v}_{actual} - \vec{v}_{reference}$



Projectile Motion

Projectile Fired Horizontally

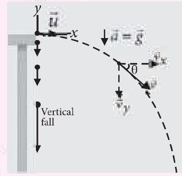
Equation of trajectory: $y = \frac{g}{2u^2}.x^2$

Velocity after time t: $v = \sqrt{u^2 + g^2t^2}$

$\beta = \tan^{-1}\frac{gt}{u}$

Time of flight: $T = \sqrt{\frac{2h}{g}}$

Horizontal range: $R = u\sqrt{\frac{2h}{g}}$



Projectile Fired at an Angle with Horizontal

Position after time t:

$x = (u\cos\theta)t, y = (u\sin\theta)t - \frac{1}{2}gt^2$

Equation of trajectory:

$y = x\tan\theta - \frac{g}{2u^2\cos^2\theta}.x^2$

Maximum height: $H = \frac{u^2\sin^2\theta}{2g}$

Time of flight: $T = \frac{2u\sin\theta}{g}$

Horizontal range: $R = \frac{u^2\sin 2\theta}{g}$

Circular Motion

Uniform Circular Motion

A particle moves along a circular path with a constant speed.

Angular displacement, $\theta = \frac{s}{r}$

Angular velocity, $\omega = \frac{\theta}{t}$

Also, $\omega = \frac{2\pi}{T} = 2\pi\upsilon$

Linear velocity, $v = r\omega$

Centripetal acceleration, $a = \frac{v^2}{r} = r\omega^2$

Linear acceleration, $a = r\alpha$

Non Uniform Circular Motion

Circular motion with variable speed

Resultant acceleration of the particle

$a = \sqrt{a_t^2 + a_r^2}$

$a_r = \frac{v^2}{r}$, a_t = tangential acceleration