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PHYSICS

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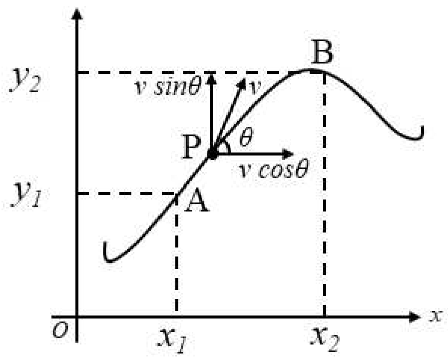
CLASS 11&12th

CLASS 11th

Motion in a Plane

01. Motion in Two Dimension

Now we change our kinematics analysis from one dimension to two dimensions. In previous sections, we've discussed about the motion of an object along a straight line. Now we discuss, what happens when a particle moves in a plane. Have a look at figure, which shows a particle moving in X-Y plane, along a two dimensional path, known as trajectory of the particle. We discuss the motion of the particle between two points of the curve *A* and *B*. If the particle is moving along the curve and its velocity at an instant is *v* at an intermediate position of particle at point *P*. In two dimensional motion, direction of velocity of a particle is always tangential to its trajectory curve. As the particle moves from point $A(x_1,y_1)$ to point $B(x_2, y_2)$. Its projection on *x*-axis changes from x_1 to x_2, and its projection of *y*-axis changes from y_1 to y_2. The velocities of the projections of the particle along *x* and *y* direction can be found by resolving the velocity of the particle in *x* and *y* direction.



If along the curve particle moves a distance *dr* in time *dt*, we define *v=dr/dt*. Similarly, when particle moves dr along the curve, its *x*-coordinate changes by *dx* and *y*-coordinate changes by *dy*. Thus the velocity projections can be written as

$$v_x = \frac{dx}{dt} = v cos\theta \quad ...(i)$$

and $$v_y = \frac{dy}{dt} = v sin\theta \quad ...(ii)$$

In standard unit vector notification we can write the instantaneous velocity of particle as

$$v = v_x\,\hat{i} + v_y\,\hat{j}$$

Squaring and adding equations (i) and (ii), gives net velocity of the particle as

$$v = \sqrt{v_x^2 + v_y^2} \quad ...(iii)$$

Dividing above equations will give the angle formed by the trajectory with the positive *x*-direction or the slope angle of the trajectory as

$$\tan\theta = \frac{v_y}{v_x}$$

or $$\theta = \tan^{-1}\frac{v_y}{v_x} \quad ...(iv)$$