

3 TWO DIMENSIONAL MOTION

1. The location of a particle in space is identified by a position vector \vec{r} directed from the origin O to a point P .

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k} \quad (3.1)$$

In this expression, $x\hat{i}$, $y\hat{j}$, $z\hat{k}$ are the vector components and x , y , z are the scalar components of the particle's position vector \vec{r} .

2. The movement of a particle from position vector \vec{r}_i to position vector \vec{r}_f is identified by a displacement vector $\Delta\vec{r}$.

$$\Delta\vec{r} = \vec{r}_f - \vec{r}_i \quad (3.2)$$

In this expression, the subscripts i and f stand for initial and final respectively. The position vector can also be written as

$$\Delta\vec{r} = (x_f - x_i)\hat{i} + (y_f - y_i)\hat{j} + (z_f - z_i)\hat{k} \quad (3.3)$$

or as

$$\Delta\vec{r} = \Delta x\hat{i} + \Delta y\hat{j} + \Delta z\hat{k} \quad (3.4)$$

where (x_i, y_i, z_i) are the coordinates of position vector \vec{r}_i and (x_f, y_f, z_f) are the coordinates of position vector \vec{r}_f .

3. The displacement $\Delta\vec{r}$ of a particle during a time interval Δt is the particle's average velocity \vec{v}_{avg} .

$$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} \quad (3.5)$$

4. The instantaneous velocity \vec{v} is the limit of the average velocity as Δt approaches zero.

$$\vec{v} = \lim_{\Delta t \rightarrow 0} \frac{\Delta\vec{r}}{\Delta t} = \frac{d\vec{r}}{dt} \quad (3.6)$$

The instantaneous velocity \vec{v} can also be written in unit-vector notation as

$$\vec{v} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k} \quad (3.7)$$

where $v_x = dx/dt$, $v_y = dy/dt$, and $v_z = dz/dt$. A particle's instantaneous velocity \vec{v} is the rate of change of its position vector \vec{r} . The magnitude of the particle's instantaneous velocity \vec{v} is the speed, and its direction is always tangent to its path at that position.

5. The change in a particle's instantaneous velocity $\Delta\vec{v}$ during a time interval Δt is its average acceleration \vec{a}_{avg} .

$$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} \quad (3.8)$$

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