Concepts of Motion:

- Motion is the change of an object's position

  Linear, Circular, Projectile — object moves through space

  Rotational — object's Angular Position changes

- Position and Time : where the object is (Position)

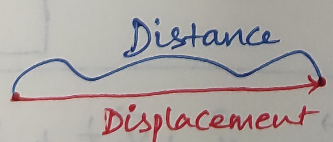
  when the object is at that position

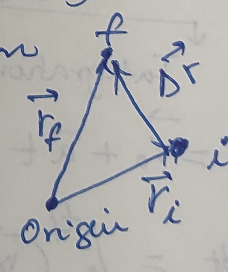
- we can measure (x,y) coordinates of each point in the motion diagram

- Scalars : physical quantity described by a number with units
- vectors : physical quantity specified completely by giving its direction and magnitude. Magnitude of a vector can not be negative, only +ve or zero.

  example: $\vec{A}$; A and $\vec{A}$ are not same, Never $\overleftarrow{A}$

- Displacement : change in the position of an object, its vector
- Distance : Total movement of an object with out any regard to the direction

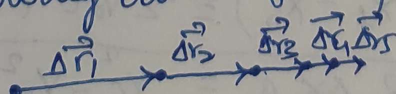




$$\vec{r_f} = \vec{r_i} + \vec{\Delta r}$$

$$\vec{\Delta r} = \vec{r_f} - \vec{r_i}$$

- Object is speeding if the Displacement vectors are increasing in length, Slowing down if displacement vectors are decreasing in length.



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- Averge Speed = $\dfrac{\text{Distance travelled}}{\text{time spent in travelling}} = \dfrac{d}{\Delta t}$

- Average velocity $\vec{V}_{ave} = \dfrac{\Delta \vec{r}}{\Delta t} = \dfrac{\text{Displacement}}{\text{time}}$

velocity and displacement points the same direction

$$\vec{V}_{ave} = \frac{\vec{X}_f - \vec{X}_i}{t_f - t_i} = \frac{\Delta X}{\Delta t} \Rightarrow \boxed{\vec{X}_f = \vec{X}_i + \vec{V}.\Delta t}$$

- Acceleration $\vec{a} = \dfrac{\vec{V}_f - \vec{V}_i}{t_f - t_i} = \dfrac{\Delta \vec{V}}{\Delta t} \Rightarrow \boxed{\vec{V}_f = \vec{V}_i + \vec{a}\,\Delta t}$

Calculus if $\vec{a}$ is a constant vector

$$\vec{a} = \frac{d\vec{v}}{dt} \quad \text{Integration} \quad \int_0^{t_f} a\,dt = \int_0^{t_f} \left(\frac{dv}{dt}\right) dt = \int_0^{t_f} dv$$

$$at = V(t_f) - V(0)$$

$$\Rightarrow \vec{V}_f = \vec{V}_0 + \vec{a}t$$

$$\Rightarrow \boxed{\vec{a} = \frac{\vec{V}_f - \vec{V}_0}{t}}$$

Instentanous Velocity $\lim_{\Delta t \to 0} \dfrac{\Delta \vec{r}}{\Delta t} = \dfrac{d\vec{r}}{dt}$

Instentanous acceleration $\lim_{\Delta t \to 0} \dfrac{\Delta \vec{V}}{\Delta t} = \vec{a}$

Integration again

$$\vec{V} = \frac{d\vec{x}}{dt} = \vec{V}_0 + \vec{a}t$$

$$\int_0^{t_f} \left(\frac{dx}{dt}\right) dt = \int_0^{t_f} (\vec{v}_0 + \vec{a}t)\,dt \Rightarrow \boxed{\vec{X}_f = \vec{X}_0 + \vec{V}_0 t + \tfrac{1}{2}\vec{a}t^2}$$

$$2(\vec{X}_f - \vec{X}_0) = 2\vec{v}_0 t + \vec{a}t^2 \quad \leftarrow \text{Substitute here}$$

$$\boxed{2\,\Delta X\,a = V_f^2 - V_0^2}$$