MOTION IN A STRAIGHT LINE

MOTION & FRAME OF REFERENCE

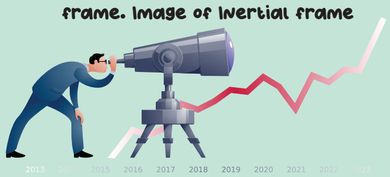
MOTION

Change in position of an object with respect to time is defined as Motion

FRAME OF REFERENCE

The point from which observer takes it's observation is called frame of reference.

Example:- Analysing lift moving upwards from ground. Observer on ground is inertial frame. Image of Inertial frame

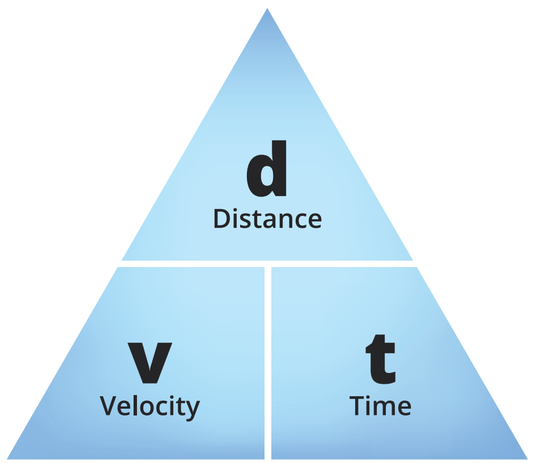


INERTIAL FRAME

- If Net external force on system is non – zero frame is non – inertial
- It is Accelerating frame.
- Frame velocity increases or decreases

NON-INERTIAL FRAME

- If Net external force on system is non – zero frame is non – inertial
- It is Accelerating frame.
- Frame velocity increases or decreases



v = d : t

t = d : v

d = v · t

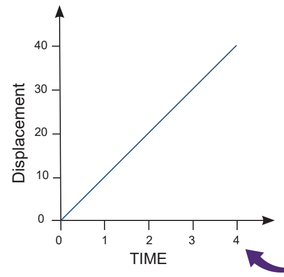
MOTION PARAMETERS

DISTANCE

- Actual Path length covered by a moving object in a given interval of time.
- Always Positive

DISPLACEMENT

- Shortest distance between the initial position and find position of moving object in a given interval of time.
- Can be Positive, Negative or Zero



SPEED

- Ratio of Path length to the corresponding time by an object
- Always Positive

VELOCITY

- The rate of change of distance of body with respect to time is defined as velocity
- Can be Positive, Negative or Zero

AVERAGE SPEED

Average Speed is defined as total distance travelled in total time

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

AVERAGE VELOCITY

Change in position or displacement divided by time intervals in which displacement occurs

$$\text{Average Velocity} = \frac{\Delta x}{\Delta t}$$

ACCELERATION

Measure of change in velocity of an object per unit time

$$a = \frac{\Delta x}{\Delta t}$$

UNIFORM MOTION & GRAPHS

- When a moving object cover equal distance in equal time intervals. It is said to be in Uniform motion.
  - Speed is constant.
  - Acceleration is zero

CASE.1

Average Speed = $\frac{2V_1V_2}{V_1+V_2}$

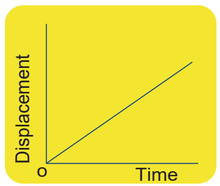
When object travels distance 'd' with velocity V_1 and next distance 'd' with velocity V_2

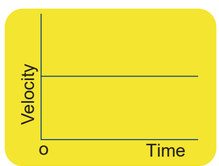
CASE.2

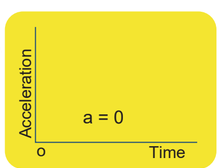
Average Speed = $\frac{V_1+V_2}{2}$

When object travels 't' interval with V1 and next 't' with V2

Average Speed = $\frac{d_1+.....+d_n}{t_1+.....+t_n} = \frac{d_1+.....+d_n}{d_1/V_1+.....+d_n/v_n} = \frac{V_1t_1+.....+V_nt_n}{t_1+.....+t_n}$







RELATIVE MOTION

- The Comparison between the motion of single object with respect to another inertial or non – inertial frame.
- This Analysis is of relative motion of an object.

UNIFORM ACCELERATED MOTION

When a body moves along a straight line and velocity changes by equal amount in equal interval of time. Motion is Uniformly accelerated motion

MOTION EQUATIONS

If acceleration is constant

(1) V = U + at

(2) $S = ut + \frac{1}{2}at^2$

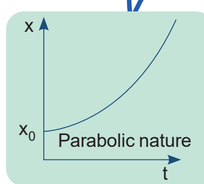
(3) V2 – U2 = 2aS

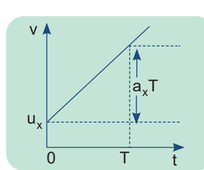
CALCULUS METHOD

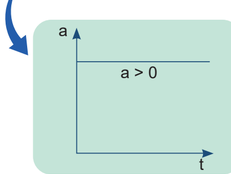
(i) $v = \frac{dx}{dt}$

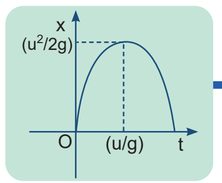
(ii) $a = v\frac{dv}{dt}$

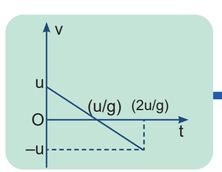
(iii) $a = \frac{dv}{dt}$

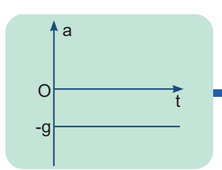












When ball is dropped from a height then it accelerates towards earth with constant acceleration.

Analysis of this motion of an object is motion under gravity

- $a_y = g = 9.8\ m/S^2$
- V = U + ayt
- $s = ut + \frac{1}{2}ayt^2$
- $V^2 - U^2 = 2ayS$

Taking downward direction as 'positive'

Relative Uniform Motion

(1) a12 = 0

(2) In this case

$V_{12} = \frac{S_{12}}{t}$

V12 = Relative Velocity

S12 = Relative displacement

Relative Uniformly Accelerated Motion

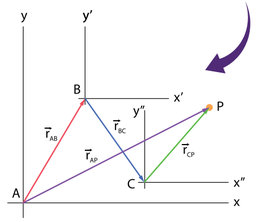
(1) $a_{12} \neq 0$

(2) In this case

$V_{12} = u_{12} + a_{12}t$

$S_{12} = u_{12}t + \frac{1}{2}a_{12}t^2$

$V_{12}^2 - u_{12}^2 = 2a_{12}S_{12}$



Time of flight

$T = \frac{2u}{g}$

Maximum Height

$H_{max} = \frac{u^2}{2g}$

Time to drop

$T = \sqrt{\frac{2h}{g}}$

Velocity after dropping

$V = \sqrt{2gh}$