

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

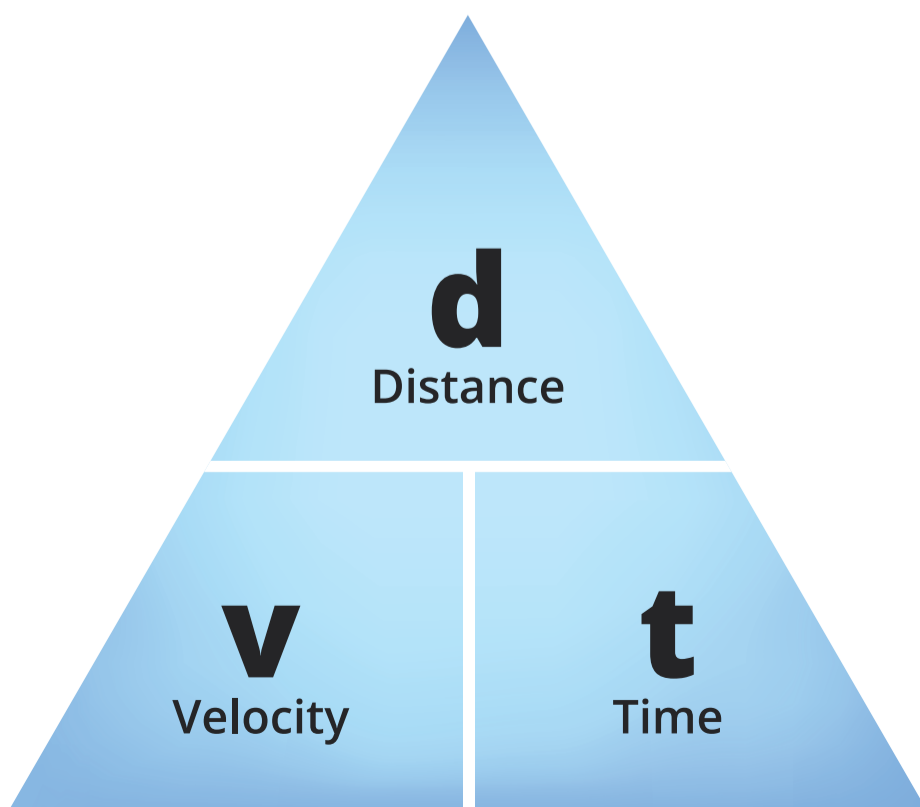


INERTIAL FRAME

- 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



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 final 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

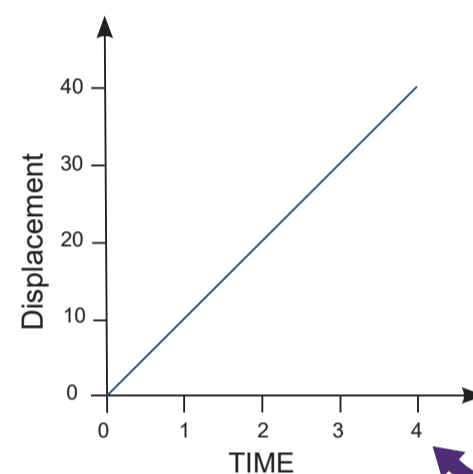
Average speed is defined as total distance travelled in total time
 Average speed = $\frac{\text{Total distance}}{\text{Total time}}$

AVERAGE VELOCITY

Change in position or displacement divided by time intervals in which displacement occurs
 Average Velocity = $\frac{\Delta x}{\Delta t}$

ACCELERATION

Measure of change in velocity of an object per unit time
 $a = \frac{\Delta v}{\Delta t}$



UNIFORM MOTION & GRAPHS

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

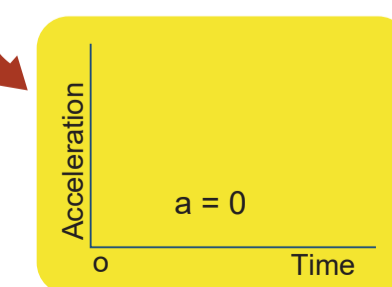
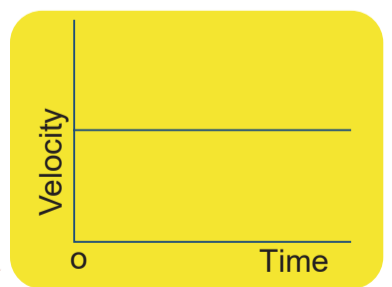
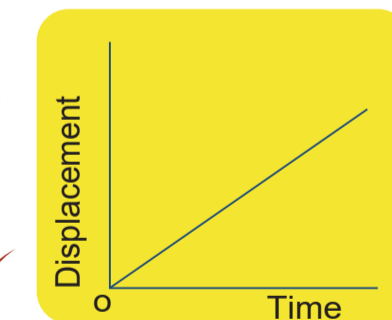
CASE.1

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 v_1 and next 't' with v_2

Average speed = $\frac{d_1 + \dots + d_n}{t_1 + \dots + t_n}$
 $= \frac{d_1/v_1 + \dots + d_n/v_n}{t_1 + \dots + t_n}$
 $= \frac{v_1t_1 + \dots + v_nt_n}{t_1 + \dots + t_n}$



UNIFORM ACCELERATED MOTION

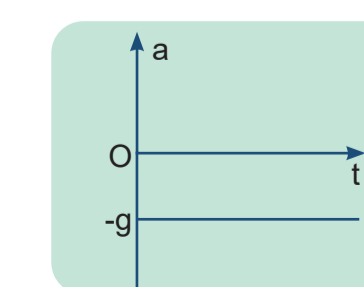
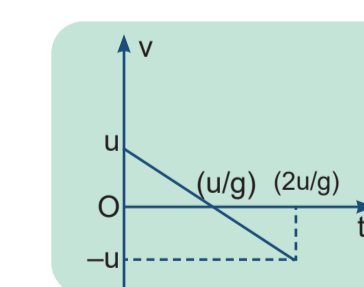
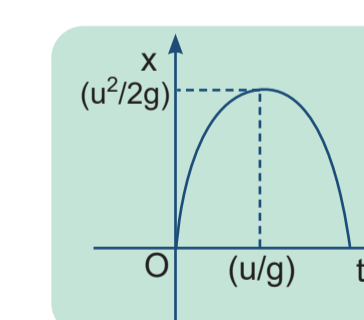
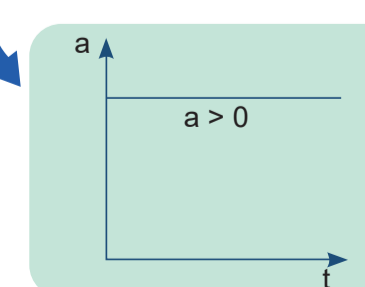
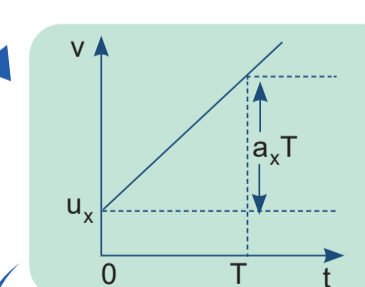
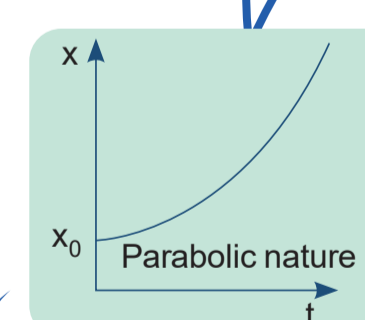
When a body moves along a straight line and velocity changes by equal amount in equal intervals of time, motion is uniformly accelerated motion

MOTION EQUATIONS

- If acceleration is constant
- (1) $v = u + at$
 - (2) $s = ut + \frac{1}{2}at^2$
 - (3) $v^2 - u^2 = 2as$

CALCULUS METHOD

- $v = \frac{dx}{dt}$
- $a = v \frac{dv}{dt}$
- $a = \frac{dv}{dt}$



RELATIVE MOTION

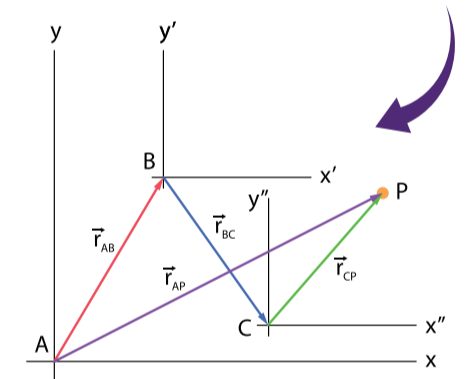
- The Comparison between the motion of single object with respect to another inertial or non-inertial frame.
- This analysis is of relative motion of an object.

Relative Uniform Motion

- (1) $a_{12} = 0$
- (2) In this case
 $V_{12} = \frac{S_{12}}{t}$
 V_{12} = Relative Velocity
 S_{12} = Relative displacement

Relative Uniformly Accelerated Motion

- (1) $a_{12} \neq 0$
- (2) In this case
 $V_{12} = u_{12} + a_{12}t$
 $S_{12} = u_{12}t + \frac{1}{2}a_{12}t^2$
 $V_{12}^2 - u_{12}^2 = 2a_{12}S_{12}$



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

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

Analysis of this motion of an object is motion under gravity

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

$a_y = g = 9.8 \text{ m/s}^2$

$v = u + ayt$

Time to drop
 $T = \sqrt{\frac{2h}{g}}$

$s = ut + \frac{1}{2}ayt^2$

$v^2 - u^2 = 2ays$

Velocity after dropping
 $V = \sqrt{2gh}$

Taking downward direction as 'positive'