MOTION

Change in position of an object with respect to the surrounding and the time is defined as Motion.

FRAME OF REFERENCE

The point from which an observer takes his observation is called frame of reference. Example:- Observing the lift motion upward or downward from ground. Observer on ground is in inertial frame.

INERTIAL FRAME

If an Observer is observing a phenomenon from ground or inside stationary frame where frame velocity is zero or constant, it is defined as Inertial frame of reference.

NON-INERTIAL FRAME

If an Observer is observing a phenomenon from an accelerated frame where frame velocity is either increasing or decreasing is defined as non-Inertial frame of reference.

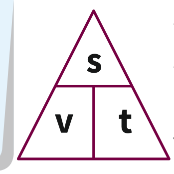
MOTION PARAMETERS

DISTANCE (d)

- Actual path length covered by a moving object in a given interval of time.
- Either zero or positive.

DISPLACEMENT (s)

- Shortest distance between the initial position and final position of moving object in a given interval of time.
- Can be positive, negative or Zero.



$s = v \times t$

$v = \frac{s}{t}$

$t = \frac{s}{v}$

2. MOTION IN A STRAIGHT LINE

VELOCITY

- The rate of change of displacement of body with respect to time is defined as velocity.
- Can be positive, negative or zero.

AVERAGE VELOCITY

The ratio of net displacement of the particle to the total time taken gives the average velocity.

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

SPEED

- Ratio of path length to the corresponding time by an object.
- Either zero or positive.

AVERAGE SPEED

Average speed is defined as total distance travelled in total time.

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

ACCELERATION

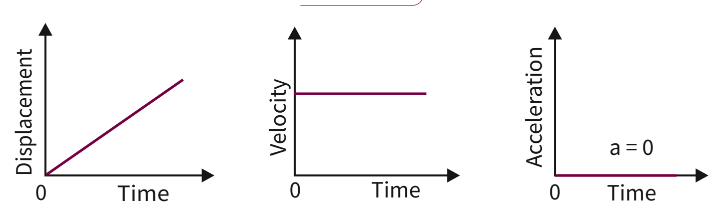
The rate of change of velocity is defined as acceleration.

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

UNIFORM MOTION

- 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

GRAPHS



CASE 1

When object travels distance 'd' with velocity v_1 and next distance 'd' with velocity v_2.

$$\text{Average speed} = \frac{2v_1v_2}{v_1 + v_2}$$

CASE 2

When object travels in time 't' interval with v_1 and next 't' with v_2

$$\text{Average speed} = \frac{v_1 + v_2}{2}$$

$$\text{Average speed} = \frac{d_1 + d_2 + \ldots\ldots . d_n}{t_1 + t_2 + \ldots\ldots . t_n}$$

$$= \frac{d_1 + d_2 + \ldots\ldots . d_n}{d_1/v_1 + d_2/v_2 + \ldots\ldots . d_n/v_n}$$

$$= \frac{v_1t_1 + v_2t_2 + \ldots\ldots . v_nt_n}{t_1 + t_2 + \ldots\ldots . t_n}$$

UNIFORMLY 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.

EQUATIONS OF MOTION

If acceleration is constant

1) $v = u + at$

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

3) $v^2 - u^2 = 2as$

4) $s_n = u + \frac{a}{2}(2n - 1)$

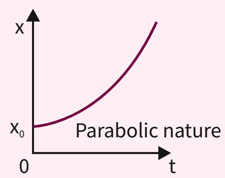
CALCULUS METHOD

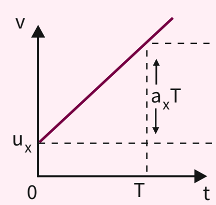
1) $v = \frac{ds}{dt}$

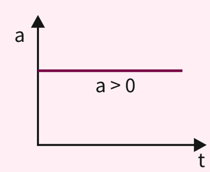
2) $a = \frac{dv}{dt}$

3) $a = v\frac{dv}{ds}$

Graphs of uniformly accelerated motion







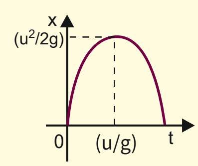
CALCULUS METHOD

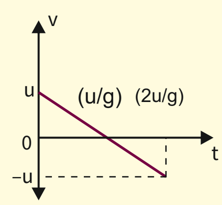
1) $\int ds = \int v\, dt$

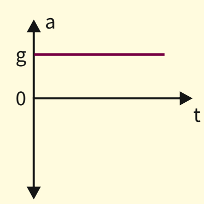
2) $\int dv = \int a\, dt$

3) $\int a\, ds = \int v\, dv$

Graphs to show of motion under gravity







RELATIVE MOTION

The Comparison between the motion of single object with respect to another inertial or non – inertial frame.

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.
Analysis of this motion of an object is motion under gravity.

$u = 0;\ a = g = 9.8\ m/s^2$

$v = gt$

$v^2 = 2gs$

$s = \frac{1}{2}gt^2$

Taking downward direction as 'positive'.

Freely falling body

Time of decent of freely falling body $T = \sqrt{\frac{2h}{g}}$

Final velocity of freely falling body $v = \sqrt{2gh}$

Body thrown Vertically Up

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

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