Date: _____ Day: _____

Formula Sheet

Unit no :- 03 Force & Motion

Displacement :- Change in position of a body. $\vec{d} = \Delta\vec{r} = \vec{r}_2 - \vec{r}_1$
vector quantity, SI unit (m), Dimension [L].

Velocity :- Rate of change of displacement. $\vec{v} = \frac{\Delta\vec{d}}{\Delta t}$ vector quantity,
SI unit (ms^{-1}), Dimension $[LT^{-1}]$.

Average velocity :- $\vec{v}_{av} = \Delta\vec{d}/\Delta t$ **Instantaneous velocity :-** $\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta\vec{d}}{\Delta t}$

Accelesation :- Rate of change of velocity. $\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$ vector quantity
Dimension $[LT^{-2}]$. SI unit (ms^{-2})

Average accelesation :- $\vec{a}_{av} = \Delta\vec{v}/\Delta t$ **Instantaneous accelesation** $\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta\vec{v}}{\Delta t}$

Uniform velocity :-
$\vec{v}_{av} = \vec{v}_{ins}$

Variable velocity :-
$\vec{v}_{av} \neq \vec{v}_{ins}$

Uniform accelesation :-
$\vec{a}_{av} = \vec{a}_{ins}$

Variable accelesation :-
$\vec{a}_{av} \neq \vec{a}_{ins}$

Equation of motion

- Motion (direction) doesn't change
- Accelesation must be uniform

$v_f = v_i + at$

$s = \frac{(v_f + v_i)}{2} \times t$

OR

$s = v_i t + \frac{1}{2} a t^2$

$v_f^2 = v_i^2 + 2as$

Newton's 1st law :- Unless an external force is applied object remains at rest while object in motion continue their motion.
"Law of interia" Interia $\propto$ mass

Newton's 2nd law :- A net force applied produces accelesation in a body is directly proportional to the magnitude of net force and inversely proportional to the mass of object.
$F = ma$ (Unit N) newton

Newton's 3rd law :- To every action there is always an equal but opposite reaction. Which have same magnitudes.

Linear momentum :-
The product of mass and velocity. $\vec{P} = m\vec{v}$ Vector quantity.
SI unit ($kgms^{-1}$) or (Ns), Dimension $[MLT^{-1}]$

Relation between force & momentum :-
Putting eq (ii) in (i)

$F = \frac{mv_f - mv_i}{\Delta t} \Rightarrow F = \frac{P_f - P_i}{\Delta t}$

$\vec{F} = \Delta\vec{P}/\Delta t$

Proof

$F = ma \rightarrow (i)$
$a = \frac{v_f - v_i}{\Delta t} \rightarrow (ii)$

$\Rightarrow Ns = kgms^{-2} \times s$
$\Rightarrow Ns = kgms^{-1}$

Impulse :-
$(I = F \times t)$

Cases

$v_1 \neq 0$ $v_2 \neq 0$ (m_1, m_2)
↳ $m_1 = m_2$
↳ $u_1 = v_2$
↳ $u_2 = v_1$

$v_1 \neq 0$ $v_2 = 0$ (m_1, m_2)
↳ $m_1 = m_2$
↳ $u_1 = 0$
↳ $u_2 = v_1$

$v_1 \neq 0$ $v_2 = 0$ (m_1, m_2)
↳ $m_1 << m_2$
↳ $u_1 = -v_1$
↳ $u_2 = 0$

Conservation of momentum :- $m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$

Elastic collision :- $v_1 + u_1 = u_2 + v_2$

$v_1' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \frac{2m_2u_2}{m_1 + m_2}$

$v_2 = \frac{2m_1u_1}{(m_1 + m_2)} - \frac{(m_1 - m)2u_2}{(m_1 + m_2)}$

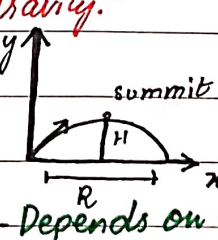
FROM PUNJAB BOARD BOOK

Rocket propulsion :- $a = mv/M$ (mass of rocket)
Conservation of bullet & riffle :- $m_bv_b + M_Rv_R = 0$
Force due to flow of water :- $f = \frac{mv_f - mv_i}{t}$

$f = \frac{0 - mv_i}{t}$ ↳ When water strikes walls it comes to rest so, $\Delta v = 0 - v_i = -v_i$

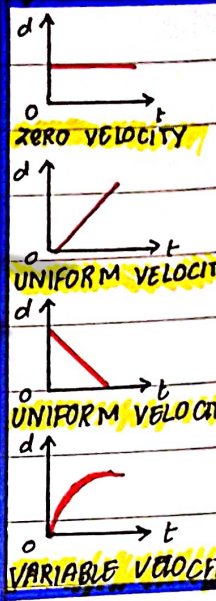
$f = \frac{-mv_i}{t}$

Projectile motion :-
Two dimensional motion under influence of gravity.



- Depends on gravity
- Initial velocity.

Graph (d-t)



Elastic collisi
$K.E_{ini} = K.E_{fin}$

Inelastic collisi
$K.E_{ini} \neq K.E_{final}$

Magnitude of velocity
$v = \sqrt{(v_x\cos)^2 + (v_y\sin)^2}$
$v = \sqrt{0 - gt)^2}$

For angle
$\phi = \tan^{-1} v_y/v_x$

Height
↳ $2as = v_f^2 - v_i^2$
$H = \frac{v_0^2 \sin^2\theta}{2g}$

Time of flight
$S = v_it + \frac{1}{2}at^2$
$a = -g$
$T = \frac{2v_i y \sin\theta}{g}$

Range & Heigh
$R = \frac{v_0^2 \sin 2\theta}{g}$
$R\tan\theta = 4H$
$R_{max} \rightarrow \theta = 45$
$R_{max} = 4H$
$\theta = 76^\circ$
$R = H$