Chapter = 03

Motion and Force

What is Difference b/w Rest and Motion?

Rest	Motion
An object is said to be in rest if it does not change its position with respect to origin	An object is said to be in state of motion if it changes its position with respect to its surroundings.
For example book lying on table	For example motion of car

What is Difference b/w Distance and displacement?

Distance	Displacement
The length of track b/w two points is called distance	"The change in position of body from its initial to final position" OR Shortest distance b/w two points is called displacement
It is scalar quantity and its unit is meter [L]	It is vector quantity and its unit is meter [L]
Magnitude of displacement is distance	Its formula is $\vec{d}=\vec{r}_2-\vec{r}_1$, where $\vec{r}_2$ and $\vec{r}_1$ are positions

What is Difference b/w Speed and velocity?

Speed	Velocity
The time rate of change of distance of body is called speed, it is denoted by v, v=distance/ time	The time rate of change of displacement of body is called velocity denoted by $\vec{v}$, $\vec{v}$=displacement/ time
It is scalar quantity	It is Vector quantity and its direction is along the direction of displacement
Formula v=d/ t and unit is meter/sec[LT^{-1}]	Formula $\vec{v}=\vec{d}/t$ and unit is meter/sec[LT^{-1}]

What is Difference b/w Average and Instantaneous velocity?

Average Velocity	Instantaneous velocity
The ratio of total displacement to the total time taken to cover displacement is called average velocity.	The velocity of a body at any instant of time is called instantaneous velocity.
$\vec{V}_{av}=\frac{\Delta\vec{d}}{\Delta t}$. Its unit is m/s	$V_{ins}= \lim \Delta t \to 0 \frac{\Delta \vec{d}}{\Delta t}$ its unit is m/s.

What is Difference b/w uniform velocity and variable velocity?

Uniform velocity	Variable velocity
If the body cover equal displacement in equal interval of time, the body is said to be in uniform velocity	If the body covers unequal displacement in equal interval of time, the body is said to be in variable velocity.
In uniform velocity, instantaneous velocity is equal to average velocity of a body	In variable velocity, instantaneous velocity is not equal to average velocity of a body, it may be changed.

Acceleration: The time rate of change of velocity of a body is called Acceleration. $\vec{a}$=change in velocity/time, $\vec{a}=\vec{v}/t$. It is vector quantity and its direction is along the direction of change in velocity. Its SI unit is ms^{-2} [LT^{-2}].

What is Difference b/w Average and instantaneous Acceleration?

Average Acceleration	Instantaneous Acceleration
The ratio of the total change in velocity to the total time taken is called average acceleration	The acceleration of a body at any instant of time is called instantaneous acceleration
Its formula is $\vec{a}_{av}=\frac{\Delta\vec{v}}{\Delta t}$	$\vec{a}_{ins} = = \lim \Delta t \to 0 \frac{\Delta \vec{v}}{\Delta t}$

What is Difference b/w uniform Acceleration and variable Acceleration?

Uniform Acceleration	Variable Acceleration
A body is said to be moving with uniform acceleration if its average and instantaneous velocity are equal	A body is said to be moving with variable acceleration if its average and instantaneous velocity are not equal

What is Difference b/w Positive and Negative Acceleration?

Positive acceleration	Negative acceleration
If the velocity of body is increasing then acceleration is positive	If the velocity of body is decreasing then acceleration is negative, it is also called retardation or deceleration.

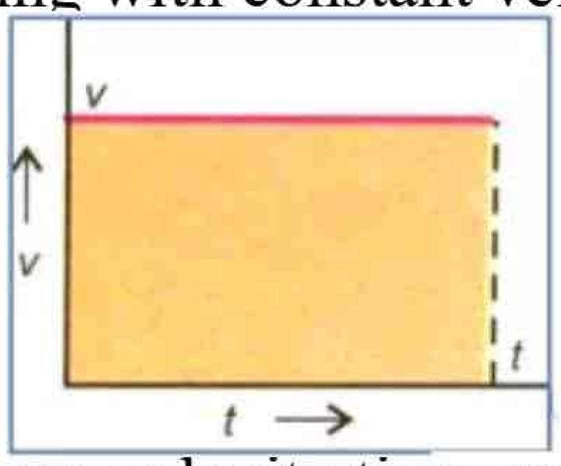
Write a note on Velocity time Graph.

Graph: The pictorial relationship b/w two quantities is called graph.

Velocity time graph: The graph which describe the relations ship b/w velocity and time is called velocity time graph.

The velocity-time graph representation for the motion along straight line is as follows:

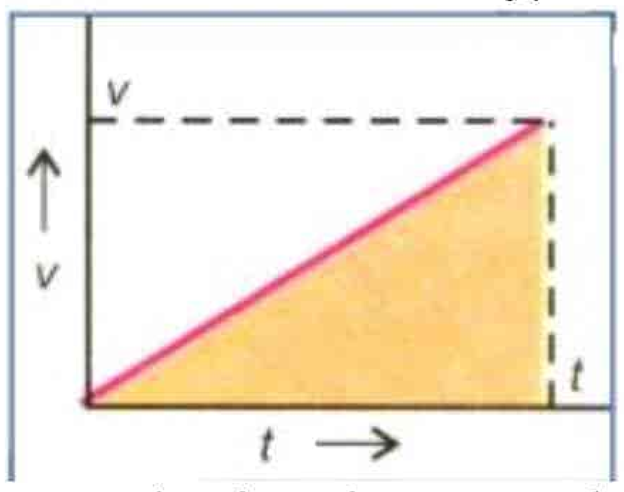
Case 01: When an object is moving with constant velocity: In this case velocity time graph is horizontal straight line parallel to X-axis or time axis. The distance covered by the object moving with constant velocity can be calculated by calculating the area of under the straight line



Distance=Area of rectangle= Length x width

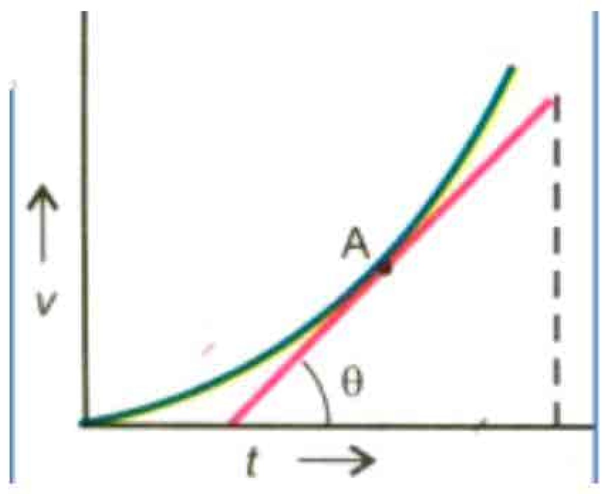
$S=V\times t=Vt$ $S=Vt$

Case 02: When an object is moving with uniform Acceleration: In this case velocity time graph is straight line inclined to time axis (X-axis). The distance covered can be calculated by area under this triangle



Distance= $S= 1/2\ (base*height) = ½\ (V*t)$ $S= ½\ Vt$.

Case 03When an object is moving with variable Acceleration: In this case velocity time graph is a curve. The instantaneous acceleration at point A on curve is equal to slope of tangent.



Significance of Velocity time graph: Velocity time graph is used

- To find Average acceleration of object from slope of V-t graph
- To find the distance by calculating the area under the V-t graph.

Give Equations of motion.

Equations of motion for uniformly motion: When an object is moving with uniform acceleration then equations

I. $V_f=V_i+at$	II. $S=V_it+ ½ at^2$
III. $2as=V^2_f-V^2_i$	IV. $S=(V_f+V_i)/2*t$

Note: These equations are useful for rectilinear motion of an object.

Equations of motion when a body falls with uniform gravitational acceleration g in the absence of air friction

(1) $V_f=V_i+gt$ (2) $h=V_it+ ½ gt^2$ (3) $2gh=V^2_f-V^2_i$

Sign of acceleration is positive when object is falling under the action of gravity, sign of acceleration is negative when object is moving upward again the force of gravity.

State Newton laws of Motion.

These laws was stated by Isaac Newton in his famous book "Principia Mathematica" in 1687

Newton law of inertia/First law of motion:
"A body at rest will remain at rest and a body moving with uniform velocity will continue to do so, unless unbalance external force acts on it". It is also called law of inertia a=0.
Inertia: The property of a body due to which it tend to maintain its state or rest or uniform motion is called inertia.
Definition of mass in terms of inertia. Quantitative measurement of inertia is called mass.
Inertial frame of reference: The frame of reference in Newton's first law of motion hold is called inertial frame of reference. As Earth is approximately an inertial frame of reference.

Newton 2nd law of motion: When a force is applied on a body, it produces the acceleration in it own direction, which is directly proportional to applied force and inversely proportional to mass, $\vec{F} = m\vec{a}$.

Newton third law of motion: "Action and reaction are equal in magnitude and opposite in direction" e.g when two bodies interact with each other like Our walk on ground. Action and Reaction never act on same body but always act on different bodies.

What is Momentum? Write its formula and unit.

Definition of momentum: The product of mass and velocity of moving body is called momentum. $\vec{P} = m\vec{v}$
Its unit is kgm/s or Ns and dimension [MLT^{-1}], it is vector quantity.
For example momentum defines how easy or difficult to stop a moving body. When two bodies of same masses moving with different velocities, then it is difficult to stop the body whose velocity is larger.

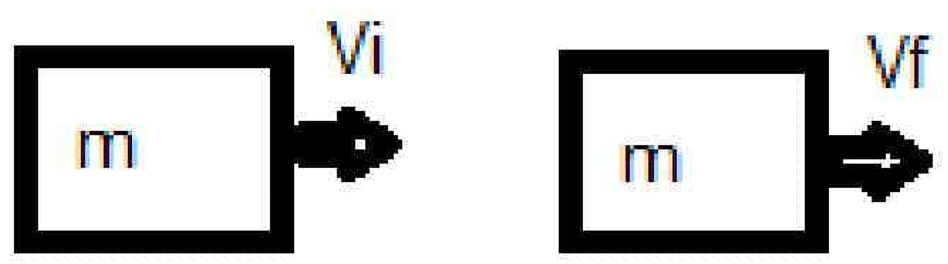
State and explain Newton 2nd law in term of linear momentum.

Statement: "Time rate of change of momentum of body is equal to the applied force". $F = \frac{mvf - mvi}{t} = \frac{\Delta P}{t}$

Proof: Let us consider an object of mass m is moving with velocity v, when external force acts on it for time t, then its velocity changes from Vi to Vf,.

$$a = \frac{V_f - V_i}{t} \text{ --------- } (1)$$

$$a = \frac{F}{m} \text{ ------------- } (2) \quad \text{comparing both equations}$$



$$\frac{F}{m} = \frac{V_f - V_i}{t}$$

$$Fxt = m(V_f - V_i) = mV_f - mV_i = \Delta P$$

$$F = \frac{\Delta P}{t} \quad \text{This is Newton 2nd law in terms of linear momentum}$$

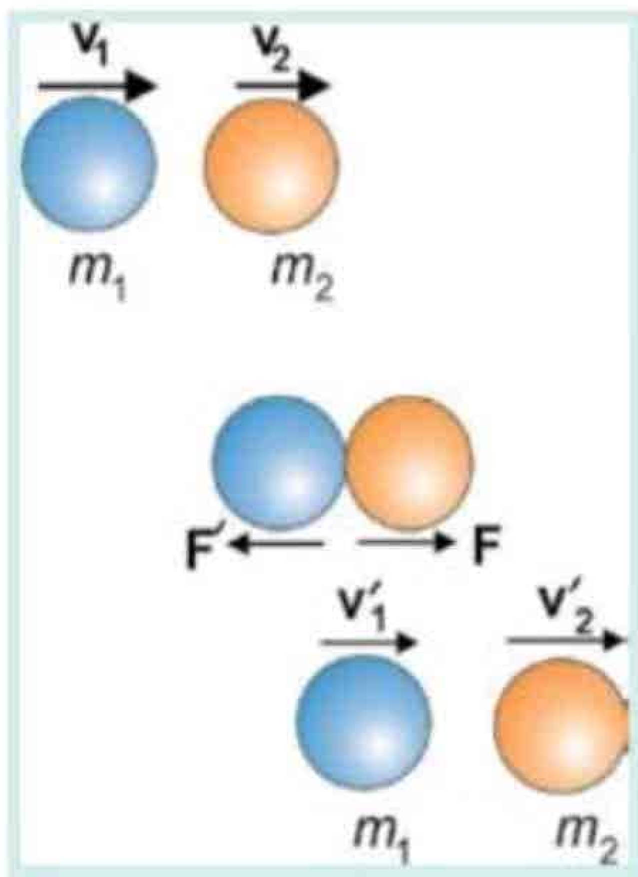
What is Impulse And Impulsive Force?

Impulse: When a large force acts on a body for a very short interval of time, then the product of force and time for which force acts, is called impulse. $\vec{I} = \vec{F}xt = \Delta\vec{P}$, its SI unit is Ns, it is vector quantity.
Impulsive Force: A force acting on a body for very short interval of time is called impulsive force. When a ball hit the bat during stroke of batsman.

State and Explain Law of conservation of linear momentum.

Isolated system: Such a system on which no external force acts is called isolated system. e.g. molecules of gas in cylinder at constant temperature.

Statement of law of conservation of linear momentum: Total linear momentum of an isolated system remains constant. **OR** For an isolated system, total momentum before collision is equal to total momentum after collision.
Equation: Total momentum before collision=Total momentum after collision $m_1v_1+m_2v_2=m_1v_1'+m_2v_2'$
Explanation/Proof: Let us consider an isolated system of two smooth hard balls of mass m_1 and m_2 moving with velocities v_1 and v_2 in same direction before collision and after collision velocities becomes v_1' and v_2'.
We can find change in momentum by using Newton 2nd law of motion



For m_1 initial momentum $P_i = m_1v_1$ and final momentum $P_f = m_1v_1'$

$$Fxt = \Delta P = P_f - P_i$$

$$Fxt = m_1v_1' - m_1v_1 \text{ ---------- } (1)$$

Similarly for mass m_2 initial momentum $P_i = m_2v_2$ and final momentum $P_f = m_2v_2'$

$$F'xt = m_2v_2' - m_2v_2 \text{ ---------- } (2)$$

Adding equation (1) and (2)

$$(Fxt) + (F'xt) = (m_1v_1' - m_1v_1) + (m_2v_2' - m_2v_2)$$

$$(F + F')t = m_1v_1' - m_1v_1 + m_2v_2' - m_2v_2$$

As F and F' are action and reaction forces which are equal but opposite in direction $\vec{F} = -\vec{F}'$

$$(-\vec{F} + \vec{F}) = m_1v_1' - m_1v_1 + m_2v_2' - m_2v_2$$

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$ $\Rightarrow$ Total momentum before collision = Total momentum after collision

What is Elastic collision and Inelastic collision?

Collision: When some interaction take place b/w two objects then collision is said to be occurred

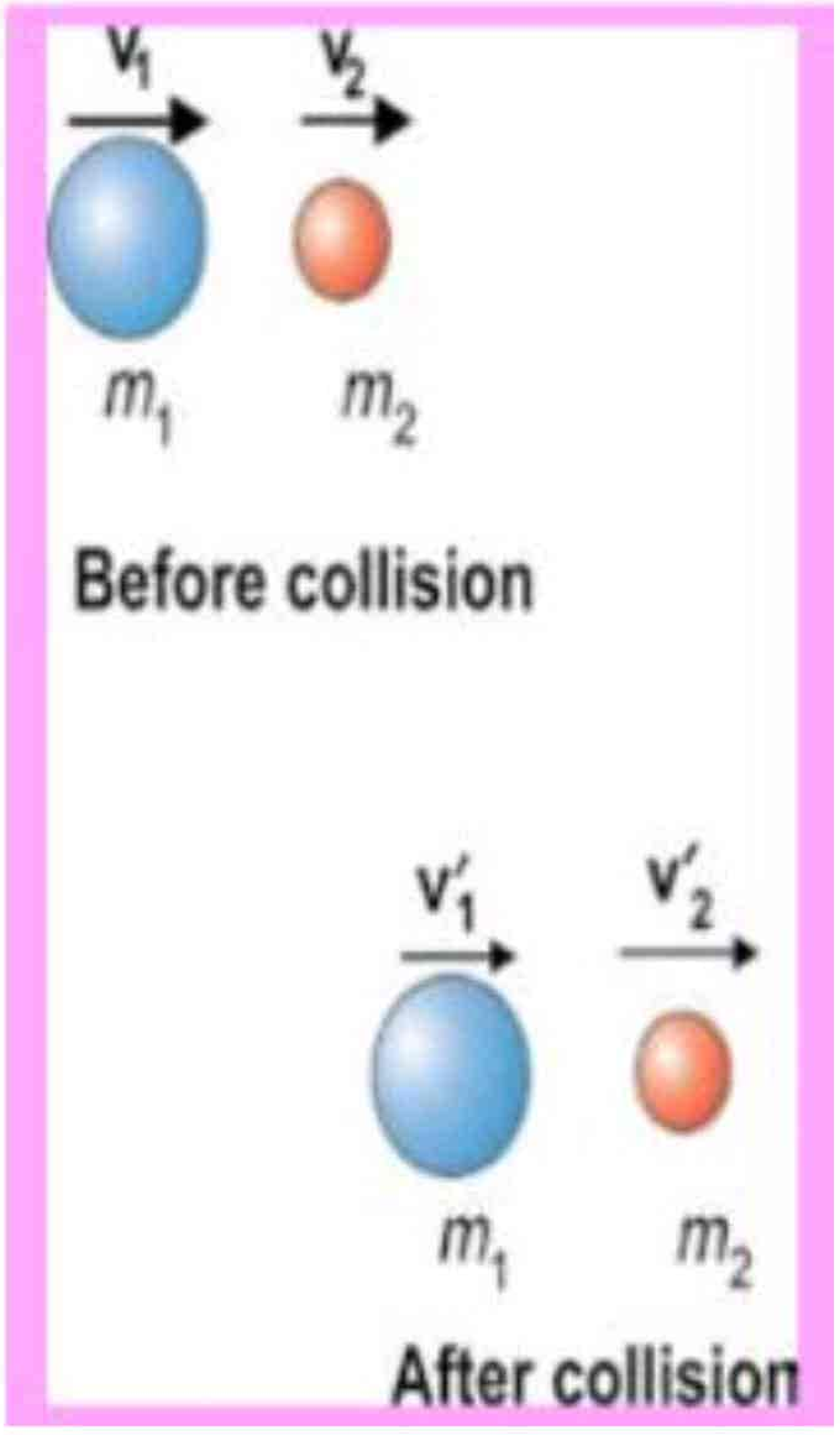
Elastic collision: The collision in which kinetic energy of system is conserved is called elastic collision. For example bouncing back of a hard ball from a marble floor.

Inelastic collision: Such a collision in which kinetic energy is not conserved is called inelastic collision. For example collision of two tennis balls.

Note: Momentum and total energy remains constant in all types of collision.

Discuss Elastic collision in one dimension.

Consider two smooth, non-rotating hard balls of masses m_1 and m_2 moving in such a way that they have linear velocities v_1 and v_2 respectively and v_1' and v_2' after collision as shown in figure.



According to law of conservation of linear momentum

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2' \quad ----------- (A)$$

$$m_1v_1 - m_1v_1' = m_2v_2' - m_2v_2$$

$$m_1(v_1 - v_1') = m_2(v_2' - v_2) \quad ----------- (1)$$

Now applyinglaw of conservatio of K.E

$$\frac{1}{2}m_1v^2{}_1 + \frac{1}{2}m_2v^2{}_2 = \frac{1}{2}m_1v^2{}_1' + \frac{1}{2}m_2v^2{}_2'$$

$$\frac{1}{2}(m_1v^2{}_1 + m_2v^2{}_2) = \frac{1}{2}(m_1v^2{}_1' + m_2v^2{}_2')$$

$$m_1v^2{}_1 + m_2v^2{}_2 = m_1v^2{}_1' + m_2v^2{}_2'$$

$$m_1v^2{}_1 - m_1v^2{}_1' = m_2v^2{}_2' - m_2v^2{}_2$$

$$m_1(v^2{}_1 - v^2{}_1') = m_2(v^2{}_2' - v^2{}_2)$$

$$m_1(v_1 - v_1')(v_1 + v_1') = m_2(v_2' - v_2)(v_2' + v_2) \quad --- (2)$$

Dividing equation (2) by (1)

$$\frac{m_1(v_1 - v_1')(v_1 + v_1')}{m_1(v_1 - v_1')} = \frac{m_2(v_2' - v_2)(v_2' + v_2)}{m_2(v_2' - v_2)}$$

$$v_1 + v_1' = v_2' + v_2$$

$$v_1 - v_2 = v_2' - v_1'$$

$$v_1 - v_2 = -(v_1' - v_2') \quad ----------------------- (3)$$

$v_1 - v_2 =$ Relative velocity of m_1 w.r.t m_2 before collision

$(v_1' - v_2') =$ Relative velocity of m_1 w.r.t m_2 after collision

Determination of velocities after collision: We can calculate the velocities of both masses by solving

From equation (3) we

$$v_1 - v_2 = v_2' - v_1'$$

$$v_1' = v_2' - v_1 + v_2 \quad \text{puttingin equation(A)}$$

$$m_1v_1 + m_2v_2 = m_1(v_2' - v_1 + v_2) + m_2v_2'$$

$$m_1v_1 + m_2v_2 = m_1v_2' - m_1v_1 + m_1v_2 + m_2v_2'$$

$$m_1v_1 + m_1v_1 + m_2v_2 - m_1v_2 = m_1v_2' + m_2v_2'$$

$$2m_1v_1 + (m_2 - m_1)v_2 = (m_1 + m_2)v_2'$$

$$(m_1 + m_2)v_2' = 2m_1v_1 + (m_2 - m_1)v_2$$

Dividing both sides by $(m_1 + m_2)$

$$v_2' = \frac{2m_1v_1}{m_1 + m_2} + \frac{(m_2 - m_1)v_2}{m_1 + m_2} \quad ------ (B)$$

Again from equation $v_1 - v_2 = v_2' - v_1'$

$v_2' = v_1 - v_2 + v_1'$ puttingin equation (A)

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2(v_1 - v_2 + v_1')$$

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_1 - m_2v_2 + m_2v_1'$$

$$m_1v_1 - m_2v_1 + m_2v_2 + m_2v_2 = m_1v_1' + m_2v_1'$$

$(m_1 - m_2)v_1 + 2m_2v_2 = (m_1 + m_2)v_1'$ dividing both sides by $(m_1 + m_2)$

$$v_1' = \frac{(m_1 - m_2)v_1}{m_1 + m_2} + \frac{2m_2v_2}{m_1 + m_2} ------(C)$$

Special Cases of collision:

Case 01: When m_1 and m_2 are equal so put $m_1 = m_2 = m$ equation (B) and equation (C) to get the result

$V_1' = V_2$ and $V_2' = V_1$

Case 02: When m_1 and m_2 are equal and target is at rest mean put $m_1 = m_2 = m$ and $v_2 = 0$

$V_1' = 0$ and $V_2' = V_1$

Case 03: When lighter mass m_1 collide with massive mass m_2 at rest mean $m_1 = 0$ and $v_2 = 0$

$V_1' = -V_1$ and $V_2' = 0$

Case 04: When massive body m1 collides with lighter body m2 at rest mean $m_2 = 0$ and $v_2 = 0$

$V_1' = V_1$ and $V_2' = 2V_1$

Calculate the formula for Force due to water flow

Let the initial velocity of water is v and on striking the wall it comes to rest so final velocity becomes zero

initial velocity $= \vec{v}i = v$, initial momentum $= m\vec{v}$

final velocity $= \vec{v}_f = 0$ Final momentum $= 0$

$$\text{Force} = \frac{\text{Change in momentum}}{\text{time}} = \frac{P_f - P_i}{t} = \frac{0 - m\vec{v}}{t}$$

$F = \frac{-m\vec{v}}{t} =, \frac{-m}{t}\vec{v}$ This is the formula for force due to water flow

Example

Suppose water flows from a pipe at $3 kgs^{-1}$ and its velocity changes from $5ms^{-1}$ to 0 on striking wall

$\frac{m}{t} = 3kgs^{-1}$, $F = \frac{-m}{t}\vec{v} = 3(0 - 5) = 15N$

Describe Momentum and Explosive forces

Principle: Within isolated system total momentum remains same due to explosive forces.

Examples: There are many examples of momentum and explosive forces which are as follows

1. **Explosion of a shell or bomb**: Let a shell is exploded in the mid air and its fragments are scattered in different directions then by law of vector addition, then its total momentum of its fragments is equal to initial momentum.
2. **Firing of rifle**: Let a bullet of mass m fired from a rifle of mass M with velocity $\vec{v}$

As initial momentum is zero as both bullet and rifle are initially at rest, m is mass of bullet and M is mass of rifle

final momentum $= m\vec{v} + M\vec{v}$

apply law of conservation of linear momentum

$0 = m\vec{v} + M\vec{v}'$

$\vec{v}' = \frac{-m\vec{v}}{M}$ This is the velocity of recoil of rifle

Describe Rocket propulsion.

Working principle of Rocket motion: It based upon law of conservation of momentum and Newton third law of motion.

Working principle of Rocket: Rocket moves up by ejecting burning gases from its rear part of engine, when fuel is burned, it turns to high pressure gases with high speed. Rocket gains momentum equal to the momentum of expelled gases but in opposite direction

Fuel of rocket: Fuel is in the form of liquid or solid and oxygen. **80%** of launch mass of rocket consist of fuel only. A typical rocket consumes **10,000 kg/s.** rocket ejects the burnt gases at speed of over **4000 m/s.**

Acceleration of rocket: The acceleration of rocket can be calculated as follows

According to Newton 2^{nd} law of motion, the force exerted on gases by rocket

$$F = \frac{m\vec{v}}{t} = (\frac{m}{t})\vec{v} = m\vec{v} \quad \text{for } t = 1\text{sec}$$

$$\text{The force exerted on rocket } \vec{F} = M\vec{a}$$

$$M\vec{a} = m\vec{v}$$

$$\vec{a} = \frac{m\vec{v}}{M}$$

What is Projectile Motion? Derive the relations for velocity, time, height and range of projectile

Projectile motion: A two dimensional motion under the constant acceleration due to gravity is called projectile motion. And the objects which perform this type of motion are called projectile like

Examples: (i) A football kicked by a player (ii) A missile fired from a launching pad (iii) Bullet fired from gun

Trajectory of projectile: The path followed by projectile is called its trajectory. The trajectory of projectile is normally parabolic.

Horizontal Distance: Horizontal distance covered by projectile is $X=V_{ix}\,t$ using (S=vt)

Vertical Distance: The vertical motion of the ball is under the effect of gravity. For downward motion a=g. Hence the

Vertical displacement is calculated by 2^{nd} equation of motion. $Y=Vit+ 1/2\, gt^2= (0) + 1/2\, gt^2=1/2\, gt^2$

Instantaneous velocity: Let a projectile is fired with initial velocity v at an angle Θ with horizontal

Horizontal component of velocity: As there is no force acting on horizontal axis so velocity of horizontal component remains constant so acceleration ax=0 and Vfx= Vix= VicosΘ

Vertical component of velocity: Vertical component of velocity vary point to point by using 1^{st} eq of motion

Vfy=Vi+at= VisinΘ+(-g)t= VisinΘ-g)t Vfy=VisinΘ-gt

Magnitude of velocity: Magnitude of velocity can be calculated by using $V = \sqrt{V^2{}_{fx} + V^2{}_{fy}}$

Direction of velocity: Direction of velocity can be calculated by using $Tan\theta = \frac{V_{fy}}{V_{fx}} \Rightarrow \theta = Tan^{-1}\left(\frac{V_{fy}}{V_{fx}}\right).$

Height of projectile: "The maximum vertical distance covered by the projectile is called maximum height of projectile". For finding the value of maximum height we consider

At maximum height the vertical component of velocity vanishes Vfy = 0

also $a_y = -g$ and initial component of velocity Viy = Visin θ, using 3rd eq of motion

$$2as = Vf^2 - Vi^2 \Rightarrow \quad 2(-g)H = 0^2 - (Visin\,\theta)^2 \Rightarrow -2gH = -Vi^2\sin\theta^2$$

$$H = \frac{Vi^2\sin\theta^2}{2g}, \quad \text{This is the formula for height of projectile}$$

Time of flight: The time taken by a projectile to cover the distance from place of projection to the place where it hit the ground is called time of flight.

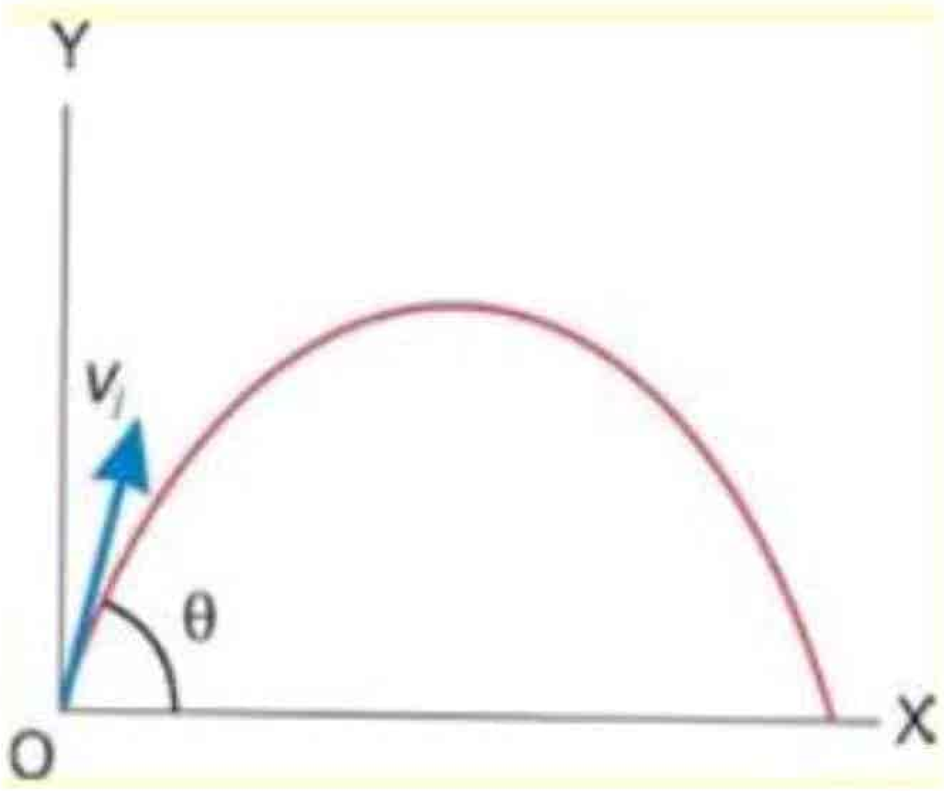
As the total vertical distance covered by body from the point of projection to a point at hitting is equal to zero so $Y = 0, a = -g, Viy = Vi\sin\theta, t = T$

using eq, $Y = V_{iy}\ t + 1/2at^2$

$$0 = Vi\sin\theta T + \frac{1}{2}(-g)T^2$$

$$\frac{1}{2}(g)T^2 = Vi\sin\theta T$$

$$T = \frac{2Vi\sin\theta}{g}$$, This is the formula for time of flight



Range of projectile: Maximum distance which a projectile covers in the horizontal direction is called range of projectile.

Range of projectile is determined by using the formula $R = Vix \times T$ $(S = vt)$

we know that $Vix = Vi\cos\theta, T = \frac{2Vi\sin\theta}{g}$

$$R = Vi\cos\theta(\frac{2Vi\sin\theta}{g}) \Rightarrow R = \frac{Vi^2}{g}(2\sin\theta\cos\theta) \Rightarrow R = \frac{Vi^2}{g}(\sin 2\theta) \quad \text{as } 2\sin\theta\cos\theta = \sin 2\theta$$

$$R = \frac{Vi^2\sin 2\theta}{g}$$, this is the formula for range of projectile

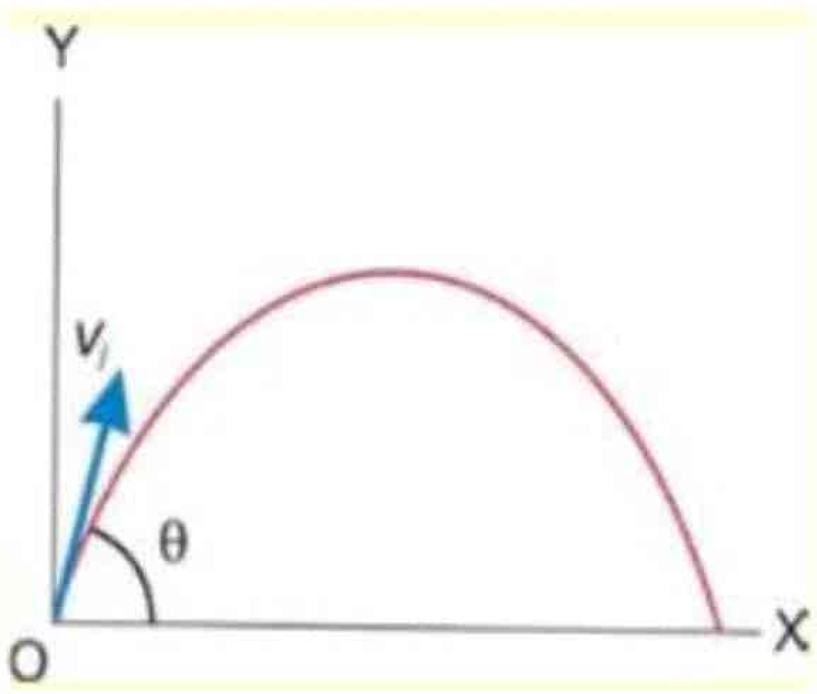
Maximum Range of projectile: The range of projectile is maximum at angle of 45°

The range of projectile is maximum when $\sin 2\theta$ has maximum value

when angle $\theta = 45^\circ$ put in formula of range

$$R_{max} = \frac{Vi^2}{g}\sin 2(45^o) = \frac{Vi^2}{g}\sin 90^o = \frac{Vi^2}{g}$$

$$R_{max} = \frac{Vi^2}{g}$$



Describe the Applications to Ballistic Missile?

Ballistic Flight: When a projectile is given an initial push and is allowed to move freely due to inertia under the action of gravity, then such a flight is called ballistic flight.

Ballistic Missile: The unpowered and unguided missile is called ballistic missile.

Ballistic trajectory: The path followed by the ballistic missile is called ballistic trajectory.

For flat earth (short range) the trajectory of projectile is parabolic and for spherical it is elliptical.

Uses of Ballistic missile: The ballistic missile are useful for short range and powered and remote control missile are useful for long range.

Chapter = 03 Exercise short Questions

1. What is the difference between uniform and variable velocity. From the explanation of variable velocity, define acceleration. Give SI units of velocity and acceleration.

Uniform velocity	Variable velocity
If the body covers equal displacement in equal interval of time then velocity is called uniform velocity	If the body covers unequal displacement in equal interval of time is called variable velocity
Rate of change of velocity is called acceleration. SI unit of velocity is m/s and acceleration is ms^{-2}.	

2. **An object is thrown vertically upward. Discuss the sign of acceleration due to gravity, relative to velocity, while the object is in air**?
Since direction of initial velocity is upward. So *g* will be negative, relative to velocity. For downward motion, g is positive with reference to the direction of initial velocity.
3. Can the velocity of an object reverse direction when acceleration is constant? If so, give an example.
Ans. Yes. For bodies freely falling back in air. If a body moves upward, finally reverse direction and moves down. The acceleration due to gravity is constant for both directions of motion.
4. Specify the correct statement:
a. An object can have a constant velocity even its speed is changing.
b. An object can have a constant speed even its velocity is changing.
c. An object can have a zero velocity even its acceleration is not zero
d. An object subjected to a constant acceleration can reverse its velocity.
Ans. Statements (b), (c) & (d) are correct. Examples of: (b) circular motion. (c) total (upward & downward) velocity is zero moving under g. (d) in the air, bodies freely falling back.

5.A man standing on the top of a tower throws a ball straight up with initial velocity vi and at the same time throws a second ball straight downward with the same speed. Which ball will have larger speed when it strikes the ground? Ignore air friction.
Ans. Upward thrown ball will have larger speed when it strikes the ground. Since it will take more time and move larger downward distance under g
6.Explain the circumstances in which the velocity v and acceleration a of a car are(i) Parallel (ii) Anti-parallel (iii) Perpendicular to one another (iv) v is zero but a is not (v) a is zero but v is not zero
Ans. (i) The car moving with increasing speed. (ii) The car moving with decreasing speed. (iii) Moving a curved or circular path. (iv) When sudden brakes are applied. (v) Moving with uniform velocity
7. Motion with constant velocity is a special case of motion with constant acceleration. Is this statement true ? Discuss.
Ans. Yes, it is true statement. When the body moves with constant velocity than change in velocity is zero so acceleration is zero and zero is also constant quantity.
8. Find the change in momentum for an object subjected to a given force for a given time and state law of motion in terms of momentum.
Ans.
$$F = ma = m(\frac{Vf - Vi}{t}) = \frac{mVf - mVi}{t} = \frac{Pf - Pi}{t} = \frac{\Delta P}{t}$$
"Time rate of change of momentum of a body equals the applied force".
9. Define impulse and show that how it is related to linear momentum.
Ans. Impulse: "The product of force and time for which it acts on a body".

$$\text{Impulse} = F \times t = ma \times t = m(\frac{Vf - Vi}{t})t = mVf - mVi = \Delta P$$
10. **State the law of conservation of linear momentum, pointing out the importance of isolated system. Explain, why under certain conditions, the law is useful even though the system is not completely isolated?**
Ans. Law of conservation of linear momentum: "The total linear momentum of an isolated system remains constant". $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$. ii) If a system is not completely isolated but external forces are very small comparing with mutual interacting forces, the law is useful. e.g. when calculating pressure of a gas and applying conservation of linear momentum, neglecting g, the external force.
11 Explain the difference between elastic and inelastic collisions.

Ans. Elastic collision: "The interaction in which both momentum and kinetic energy conserve".
Inelastic collision: "The interaction in which kinetic energy does not conserve".
In elastic collision, the bouncing ball should rebound to the original height. In inelastic collision, the bouncing ball will not rebound or will rebound to a smaller height from where it is dropped.
12. Extensive question
13 At what point or points in its path does a projectile have its minimum speed, its maximum speed?
Ans. A projectile will have its minimum speed at the highest point (maximum height). It has its maximum speed at the start and end of the projectile motion.

14 Each of the following questions is followed by four answers, one of which is correct answer. Identify that answer.

Ans (i) the correct answer is (a). A ballistic trajectory means the paths followed by an un-powered and un-guided projectile. (ii) The correct answer is (b). In elastic collision, the momentum of the system does not change.

Numerical problems

3.1: A helicopter is ascending vertically at the rate of 19.6 ms-1. When it is at a height of 156.8 m above the ground, a stone is dropped. How long does the stone take to reach the ground?

Given Data : Vi = 19.6 m/s, S = -156.8 m, g = -9.8 ms^{-2}, t = ?

using equation $S = Vit + 1/2gt^2 \Rightarrow -156.8 = 19.6t + 1/2(-9.8)t^2$

$-156.8 = 19.6t - 4.9t^2 \Rightarrow 4.9t^2 - 19.6t - 156.8 = 0$ dividing all terms by 4.9 on both sides

$t^2 - 4t - 32 = 0 \Rightarrow t(t-8) + 4(t-8) = 0 \quad \Rightarrow t - 8 = 0 \Rightarrow \quad t = 8\,sec$

3.2: Using the following data, draw a velocity-time graph for a short journey on a straight road of a motorbike.

Velocity (ms^{-1})	0	10	20	20	20	20	0
Time (s)	0	30	60	9	120	150	180

Use the graph to calculate

(a) the initial acceleration

(b) the final acceleration and

(c) the total distance traveled by the motorcyclist.

Sol : (a) initial acceleration $= a = \frac{vf - vi}{t} = \frac{20-0}{60} = 0.33 ms^{-2}$

(b) Final acceleration $= a = \frac{vf - vi}{t} = \frac{0-20}{30} = -066 ms^{-2}$

(c) Total distance = Area of ΔAOE + Area of rectangle ABDE + Area of ΔBCD

$S = \frac{1}{2}v*t + vt + \frac{1}{2}v*t = \frac{1}{2}20*60 + 20*90 + \frac{1}{2}20*30 = 600 + 1800 + 300 = 2700m = 2.7km$

3.3: A proton moving with speed of $1.0\times10^7 ms^{-1}$ passes through a 0.020 cm thick sheet of paper and emerges with a speed of $2.0\times10^6 ms^{-1}$. Assuming uniform deceleration, find retardation and time taken to pass through the paper.

given data : $v_i = 1*10^7$ m/s, $v_f = 2*10^6$ m/s, S = 0.02 cm = $0.02*10^{-2}$ m a = ? t = ?

using equation $2as = v_f^2 - v_i^2 \Rightarrow a = \frac{v_f^2 - v_i^2}{2S} = \frac{(2*10^6)^2 - (1*10^7)^2}{2(0.02*10^{-2})} = -2.4*10^{17} ms^{-2}$

$vf = vi + at \Rightarrow t = \frac{vf - vi}{a} = \frac{2*10^6 - 1*10^7}{-2.4*10^{17}} = 3.33*10^{-11}\sec$

3.4: Two masses m_1 and m_2 are initially at rest with a spring compressed between them. What is the ratio of the magnitude of their velocities after the spring has been released?

Sol : As initial momentum = Pi = 0, Final momentum = $m_1v_1 + m_2v_2$, $v_1/v_2 = ?$

According to law of conservation of linear momentum initial momentm = final momentum so

$0 = m_1v_1 + m_2v_2 \Rightarrow -m_1v_1 = m_2v_2 \Rightarrow \frac{v_1}{v_2} = \frac{-m_2}{m_1}$

3.5: An amoeba of mass $1.0\times10^{-12}kg$ propels itself through water by blowing a jet of water through a tiny orifice. The amoeba ejects water with a speed of $1.0\times10^{-4}ms^{-1}$ and at a rate of $1.0\times10^{-13}kgs^{-1}$. Assume that the water is being continuously replenished so that the mass of the amoeba remains the same.

a. **If there were no force on amoeba other than the reaction force caused by the emerging jet, what would be the acceleration of the amoeba?**

b. **If amoeba moves with constant velocity through water, what is force of surrounding water (exclusively of jet) on the amoeba?**

Given data : $m = 1*10^{-12}$ kg, speed = v = $1*10^{-4}$ m/s, m/t = $1*10^{-13}$ kg/s, F = ? a = ?

$$F = \frac{m}{t}*v = 1*10^{-13}*1*10^{-4} = 1*10^{-17}N$$

$$F = ma \quad so\ a = \frac{F}{m} = \frac{1*10^{-17}}{1*10^{-12}} = 10^{-5}ms^{-2}$$

3.6: A boy places a fire cracker of negligible mass in an empty can of 40 g mass. He plugs the end with a wooden block of mass 200g. After igniting the firecracker, he throws the can straight up. It explodes at the top of its path. If the block shoots out with a speed of 3.0 ms^{-1}, how fast will the can be going?

Given Data : $m_1 = 40g = 40*10^{-3}kg$, $m_2 = 200g = 200*10^{-3}kg$ $v_1 = ?$ $v_2 = 3ms^{-1}$

Using law of conservation of linear momentum initial momentum = final momentum

$$0 = -m_1v_1 + m_2v_2 \Rightarrow m_1v_1 = m_2v_2 \Rightarrow v_1 = \frac{m_2v_2}{m_1} = \frac{200*10^{-3}*3}{40*10^{-3}} = 15ms^{-1}$$

3.7: An electron $(m = 9.1\times10^{-31}kg)$ traveling at $2.0\times10^{7}ms^{-1}$ undergoes a head on collision with a hydrogen atom $(m = 1.67\times10^{-27}kg)$ which is initially at rest. Assuming the collision to be perfectly elastic and a motion to be along a straight line, find the velocity of hydrogen atom.

Given Data : $m_1 = 9.1*10^{-31}$ kg, $m_2 = 1.67*10^{-27}$ kg, $v_1 = 2*10^{7}$ m/s $v_2 = 0$ $v_2' = ?$

Using equation $V_2' = \frac{2m_1v_1}{m_1+m_2} + \frac{m_2-m_1}{m_1+m_2}v_2 = \frac{2m_1v_1}{m_1+m_2} + 0 = \frac{2m_1v_1}{m_1+m_2}$ as $v_2 = 0$

$$V_2' = \frac{2m_1v_1}{m_1+m_2} = \frac{2(9.1*10^{-31})(2*10^{7})}{9.1*10^{-31}+1.67*10^{-27}} = 2.18*10^{4}m/s$$

3.8: A truck weighing 2500 kg and moving with a velocity of 21 ms^{-1} collides with stationary car weighing 1000 kg. The truck and the car move together after the impact. Calculate their common velocity.

Given Data : $m_1 = 2500kg$, $m_2 = 1000kg$, $v_1 = 21$ m/s, $v_2 = 0$ common velocity = v = ?

According to law of conservation of linear momentum $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

as $v_1' = v_2' = v$ $\quad m_1v_1 + m_2v_2 = m_1v + m_2v \Rightarrow (m_1+m_2)v = m_1v_1 + m_2v_2$

$$v = \frac{m_1v_1 + m_2v_2}{m_1+m_2} = \frac{2500*21+1000*0}{2500+1000} = \frac{2500*21}{3500} = 15m/s$$

3.9: Two blocks of masses 2.0 kg and 0.50 kg are attached at the two ends of compressed spring. The elastic potential energy stored in the spring is 10 J. Find the velocities of the blocks if the spring delivers its energy to the blocks when released.

Given Data : $m_1 = 0.5\text{ kg}, m_2 = 2\text{ kg}, P.E = 10J, V_1 = ?\ V_2 = ?$

using law of conservation of linear momentum $Pi = Pf \Rightarrow 0 = m_1v_1 + m_2v_2$

$0.5v_1 + 2v_2 = 0 \Rightarrow v_1 = -4v_2 ------------(1)$

applyinglaw of conservation of energy $\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = 10\text{ J}$

$m_1v_1^2 + m_2v_2^2 = 20 \Rightarrow 0.5(-4v_2)^2 + 2v_2^2 = 20 \Rightarrow 8v_2^2 + 2v_2^2 = 20$

$10v_2^2 = 20 \Rightarrow v_2^2 = 2 \Rightarrow v_2 = 1.41\text{m/s}$ puttingin (1)

$v_1 = -4(1.41) = -5.76\text{ m/s}$

3.10:A foot ball is thrown upward with an angle of 30^o with respect to the horizontal. To throw a 40 m pass what must be the initial speed of the ball?

Given Data : $R = 40\text{ m}, \theta = 30^o, g = 9.8\text{ ms}^{-2}, v_i = ?$

$R = \frac{vi^2}{g}\sin 2\theta \Rightarrow vi^2 = \frac{gR}{\sin 2\theta} \Rightarrow \quad vi = \sqrt{\frac{gR}{\sin 2\theta}} = \sqrt{\frac{9.8*40}{\sin 2(30^o)}} = 21.3m/s$

3.11: A ball is thrown horizontally from a height of 10 m with velocity of 21 ms-1. How far off it hit the ground and with what velocity?

Given Data : $Y = h = 10m,\ vi = 21\text{ m/s}, g = 9.8\text{ ms}^{-1}, t = ?\ x = ?\ v = ?$

using $Y = v_{iy}t + 1/2gt^2 \Rightarrow 10 = 0 + 1/2*9.8t^2 \Rightarrow 4.9t^2 = 10 \Rightarrow t^2 = 10/4.9 \Rightarrow t = 1.42\sec$

$x = vi_x * t = v_i\cos\theta * t = 20\cos 0^o * 1.42 = 29.98 \approx 30m$

as $Vfx = 21\text{ m/s}$ and $Vfy = Viy + gt \Rightarrow Vfy = 0 + 9.8*1.42 = 13.99 = 14m/s$

$v = \sqrt{v_{fx}^2 + v_{fy}^2} = \sqrt{(21)^2 + (14)^2} = 25m/s$

3.12: A bomber dropped a bomb at a height of 490 m when its velocity along horizontal was 300 kmh-1. (a) How long was it in air? (b) At what distance from the point vertically below the bomber at the instant the bomb was dropped, did it strike the ground?

Given Data : $Y = h = 490m,\ vi = 300Km/h = 300*1000/3600 = 83.3m/s, g = 9.8\text{ ms}^{-1}, t = ?\ x = ?$

using $Y = v_{iy}t + 1/2gt^2 \Rightarrow 4900 = 0 + 1/2*9.8t^2 \Rightarrow 4.9t^2 = 490 \Rightarrow t^2 = 490/4.9 \Rightarrow t = 10\sec$

$x = vi_x * t = v_i\cos\theta * t = 83.3\cos 0^o * 10 = 833m$

3.13: Find the angle of projection of a projectile for which its maximum height and horizontal range are equal.

Sol : According to given condition height = range

$\frac{vi^2\sin^2\theta}{2g} = \frac{vi^2}{g}\sin 2\theta \Rightarrow \frac{\sin^2\theta}{2} = 2\sin\theta\sin\theta \Rightarrow \frac{\sin\theta}{\cos\theta} = 4 \Rightarrow \tan\theta = 4 \Rightarrow \theta = \tan^{-1}(4) = 76^o$

3.14: Prove that for angles of projection, which exceed or fall short of 45° by equal amounts, the ranges are equal.

Sol : According to given condition Range of projectile should be same for angle $\theta = 45 \pm \varphi$

$$\text{Exceed } R_1 = \frac{vi^2}{g}\sin 2(45+15)^\circ = \frac{vi^2}{g}\sin 2(60)^\circ = \frac{vi^2}{g}\sin 120^\circ = \frac{vi^2}{g}(0.866) ----(1)$$

$$\text{fall short } R_2 = \frac{vi^2}{g}\sin 2(45-15)^\circ = \frac{vi^2}{g}\sin 2(30)^\circ = \frac{vi^2}{g}\sin 60^\circ = \frac{vi^2}{g}(0.866) ----(2)$$

Hence prove ranges are equal at equal exceed or short fall in angle

3.15: A SLBM (submarine launched ballistic missile) is fired from a distance of 3000km, If the Earth is considered flat and the angle of launch is with horizontal, find the velocity with which the missile is fired and the time taken by SLBM to hit the target.

Given Data : $R = 3000\text{ km} = 3000*1000 = 3*10^6\text{ m}, \theta = 45^\circ, g = 9.8ms^{-2}, v_i = ? t = ?$

$$R = \frac{vi^2}{g}\sin 2\theta \Rightarrow vi^2 = \frac{gR}{\sin 2\theta} \Rightarrow vi = \sqrt{\frac{gR}{\sin 2\theta}} = \sqrt{\frac{9.8*3*10^6}{\sin 2(45^o)}} = 5.42*10^3 m/s$$

$$t = \frac{2vi\sin\theta}{g} = \frac{2*5.42*10^3\sin 45^o}{9.8} = 782\sec \approx 782/60\min \approx 13\min$$

Multiple choice questions

1) Typical speed of light, radio waves, x-rays and microwaves in vacuum is

a) $3*10^8$ m/s	b) $3*10^7$ m/s	c) $3*10^6$ m/s	d) $3*10^5$ m/s

2) Speed for Earth-sun travel around the galaxy

a) 210 m/s	b) 2100 m/s	c) 21000 m/s	**d) 210000 m/s**

3) Speed for Earth around the sun is

a) 2960 m/s	**b) 29600 m/s**	c) 296 m/s	d) 29 m/s

4) Typical speed for moon around the Earth is

a) 1 m/s	b) 10 m/s	c) 100 m/s	**d) 1000 m/s**

5) The typical speed for SR-71 reconnaissance jet

a) 980 m/s	b) 98 m/s	c) 9.8 m/s	d) 9 m/s

6) Speed for commercial jet airliner

a) 67 m/s	b) 167 m/s	**c) 267 m/s**	d) 367 m/s

7) Typical speed for commercial automobile (max.)

a) 60 m/s	**b) 62 m/s**	c) 64 m/s	d) 66 m/s

8) Typical speed for falcon in a dive

a) 50 m/s	**b) 37 m/s**	c) 29 m/s	d) 10 m/s

9) Speed for Running cheetah

a) 100 m/s	**b) 29 m/s**	c) 10 m/s	d) 9 m/s

10) Speed for 100-m dash(max)

a) 100 m/s	b) 90 m/s	**c) 10 m/s**	d) 29 m/s

11) What is the typical speed for porpoise swimming

a) 100 m/s	**b) 9 m/s**	c) 10 m/s	d) 29 m/s

12) Typical speed for flying bee

a) 100 m/s	**b) 5 m/s**	c) 10 m/s	d) 29 m/s

13) Typical speed for human running

a) 2 m/s	**b) 4 m/s**	c) 6 m/s	d) 8 m/s

14) Typical speed for human swimming

a) <u>2 m/s</u>	b) 4 m/s	c) 6 m/s	d) 6 m/s

15) Typical speed for walking ant

a) 1 m/s	b) 0.1 m/s	**c) <u>0.01 m/s</u>**	d) 0.001 m/s

16) At the surface of the Earth, in situation where air friction is negligible, objects of different masses fall with the acceleration

a) Different	**b) <u>Same</u>**	c) Zero	d) None

17) "No body begins to move or comes to rest of itself" statement given by

a) Newton	**b) <u>Abu Ali Sena(980-1037)</u>**	c) Einstein	d) Churchil

18) Throwing a package onto shore from a boat that was previously at rest causes the boat to move--- from shore

a) Inward	**b) <u>Outward</u>**	c) Both A&B	d) None

19) A force of 5 N might be enough to fracture naked skull but with a covering with skin and hair, a force of – is needed

a) 10 N	b) 20 N	**c) <u>50 N</u>**	d) 100 N

20) When a moving car stops quickly, the passenger move

a) Backward the windshield	**b) <u>Forward towards the windshield</u>**	c) Both A&B	d) None

21) In thrill machine rides at amusement park, there can be acceleration

a) <u>3g or more</u>	b) 3g or less	c) Zero	d) Infinite

22) For an angle less than --- the height reached by the projectile and ranges will be less

a) 30°	**b) <u>45°</u>**	c) 60°	d) 90°

23) When the angle of projectile is larger than --- the height attained will be more the range is less again.

a) 30°	**b) <u>45°</u>**	c) 60°	d) 90°

24) In the presence of air friction the trajectory of a high speed projectile fall short of a ---- path

a) Straight path	**b) <u>Parabolic path</u>**	c) Elliptical path	d) Circular path

<u>Previous all Punjab Boards Exam Solved MCQs</u>

	Questions	Option A	Option B	Option C	Option D
1)	Laws of motion are not valid in a system which is	Moving with uniform velocity	At rest	Isolated	**<u>Non inertial</u>**
2)	What is angle of projection for which the maximum height and range are equal	46°	66°	56°	**<u>76°</u>**
	Put H=R to get the result also see the solution of numerical 3.13 for explanation				
3)	Horizontal range at angle of 30° with horizontal is same as that of angle of	0°	30°	45°	**<u>60°</u>**
4)	The product of force and time is called	**<u>Impulse</u>**	Power	Torque	Velocity
5)	The range of projectile is directly proportional to	sinΘ	**<u>Sin2Θ</u>**	2sinΘ	Θ
6)	For angle less then --- the height reached by projectile and range will be less	15°	30°	**<u>45°</u>**	60°
7)	Rocket equation is given by	a=M/mv	a=Mv/m	**<u>a=mv/M</u>**	a=m/MV
8)	If a force of 10N acts on a body of mass 5kg for one second then rate of change in momentum will be	**<u>10 Ns</u>**	50 Ns	5 Ns	2Ns
	As t=1sec, F=10N, then apply 2nd law in terms of momentum				

9)	Rate of change of momentum is equal to	**Force**	Impulse	Torque	Inertia
10)	Area under velocity time graph gives	**Distance**	Displacement	Acceleration	Force
11)	How large a force is required to accelerate a body of weight 5N with 4 m/s2	10 N	5N	**2N**	1N
12)	Horizontal component of velocity of projectile is given by	**Remains constant**	Increase	Decrease	Zero
13)	SI unit of impulse is	Kgm/s	Ns	N	**Both A&B**
14)	A long jumper should long jump at an angle of	30°	90°	**45°**	60°
15)	The ballistic missile are useful for	**Short range**	Long range	Medium range	None of these
16)	A rocket eject the burnt gas at speed of	1000 m/s	2000 m/s	3000 m/s	**4000 m/s**
17)	The decrease in velocity per unit time is given as	Acceleration	Uniform acceleration	**Retardation**	Negative velocity
18)	If no kinetic energy is lost then collision is	**Elastic**	Inelastic	Both A&B	None of these
19)	If a body moves towards earth , neglecting air resistance and small changes in acceleration with altitude, what is such motion?	Gravitational	**Free fall**	Rectilinear	Uniform
20)	If a force of 12 N acts on a car and changes its momentum from 36 kgm/sec to 60 kgm/sec, the time during which this change occurs will be	**2sec**	12 sec	8 sec	24 sec
$F=\frac{\Delta P}{t}, t=\frac{Pf-Pi}{F}=\frac{60-36}{12}=2\sec$					
21)	What never changes when two or more objects collide in isolated system	Kinetic energy of each one	Momentum of each one	**Total momentum of all objects**	Total kinetic energy of all objects
22)	The range of projectile is same for pair of angle	$30^\circ,45^\circ$	**$30^\circ,60^\circ$**	$60^\circ,90^\circ$	$45^\circ,90^\circ$
23)	The ratio of displacement along diameter of circle and total distance along circle is	**1:π**	2:π	π:1	π:2
As displacement =2r, and total distance of circle is circumference of circle=2πr, dividing to ratio which 1:π					
24)	A 1kg block slides down a smooth inclined surface whose height is 5m then velocity at bottom is	m/s	5 m/s	**9.8 m/s**	7 m/s
$V=\sqrt{2gh}=\sqrt{2*9.8*5}=9.8$					
25)	A ball is thrown above with angle of 30°. The height attained by the ball is 11.5m then launching velocity of ball is	20 m/s	60 m/s	**30 m/s**	45 m/s
Put θ=30°, H=11.5 m, Vi=? Putting values in the formula of height to get the value of Vi					
26)	Time of flight of projectile when it is projected from ground is	$\frac{Vi\sin\theta}{g}$	$\frac{2Vi\sin\theta}{g}$	$\frac{Vi\sin^2\theta}{g}$	$\frac{Vi^2\sin^2\theta}{g}$

27)	The component of velocity that remains constant during motion of projectile is	Vertical	**Horizontal**	Initial	Both A&B
28)	For a rocket change in momentum per second of eject gases is equal to	Acceleration of rocket	Momentum of rocket	Velocity of rocket	**Thrust acting on rocket**
29)	One dyne is equal to	**10^{-5} N**	10^{5} N	10^{12} N	10^{9}N
30)	A body is moving with an initial velocity of 2 kms-1. After a time of 50 secs its velocity becomes 1.5 kms-1. Its acceleration will be	30 ms-1	20 ms-1	10 ms-1	40 ms-1
$a=\frac{Vf-Vi}{t}=\frac{2km/s-1.5km/s}{50}=\frac{0.5km/s}{50}=\frac{0.5*1000}{50}=\frac{500}{50}=10ms^{-2}$					
31)	Slope of velocity time graph gives	Velocity	Distance	**Acceleration**	Force
32)	Arshad is driving down 7th street, he drives 150m in 18s.. Assume he does not speed up or slow down, what is his speed:	0.38 m/s	**8.33 m/s** V=S/t to get result	126 m/s	58.33 m/s
33)	Motion of projectile is --- dimension	One	**Two**	Three	Four
34)	For maximum range the angle of projection of projectile must be	30^{o}	60^{o}	**45^{o}**	90^{o}
35)	The distance travelled by a moving car with velocity 15 m/s in 2s, decelerates at -2m/s-2 is equal to:	30m	16m	26m	34m
$S=Vit+1/2at^2 \quad =15*2+1/2*(-2)*(2)^2 \quad =30-4=26m$					
36)	The distance covered by a free falling body in 2 sec will be	4.9 m	**19.6 m**	9.8 m	39.2 m
S=1/2 gt^2= ½*9.8*2^2=19.6m					
37)	The mass of an object is a quantitative measure of	Moment of force	Acceleration	**Inertia**	Velocity
38)	In the projectile motion the vertical component of velocity	Remains constant	**Varies point to point**	Becomes zero	Increase with time
39)	Change in momentum is called	Force	Acceleration	Torque	**Impulse**
40)	Which expression represents instantaneous velocity of body	**$\lim_{\Delta t\to 0}\frac{\Delta d}{\Delta t}$**	$\lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t}$	$\lim_{\Delta t\to 0}\frac{\Delta p}{\Delta t}$	$\lim_{\Delta t\to 0}\frac{\Delta L}{\Delta t}$
41)	An alternate unit to kgm/s is	JS	**Ns**	Nm	N
42)	The motion of rocket is in accordance with law of conservation of	**Linear momentum**	Energy	Mass	Angular momentum
43)	The formula for maximum range of projectile is given by	$\frac{V^2 i}{g}$	$\frac{V^2 i\sin\theta}{g}$	$\frac{V^2 i\cos\theta}{g}$	$\frac{V^2 i\sin 2\theta}{g}$
44)	Which force accelerate the car along a road	Force of car	**Force reactional force of road**	Applied force	Engine force
45)	Acceleration of bodies of different masses allowed to fall freely is	**The same**	Variable	Different	None of these
46)	Powered and remote control guided missile are used for	Medium ranges	Short ranges	**Long range**	Half
47)	Dimension of impulse are similar to the dimension of	Work	Torque	Force	**Momentum**

48)	A body is allowed to fall freely from certain height, it cover a distance in first two second	**2g**	g	g/2	None of these
Apply 2nd eq of motion Vi=0, $S=1/2\ gt^2=1/2\ g(2)^2=2g$					
49)	The equation of motion are not useful for objects moving with	Uniform velocity	Uniform acceleration	Variable velocity	**Variable acceleration**
50)	When a ball is thrown straight up, the acceleration at its highest point is	Upward	**Downward**	Zero	Horizontal
51)	The range of projectile is same for	$0^o, 45^o$	**$35^o, 55^o$**	$15^o, 60^o$	$30^o, 75^o$
52)	Which pair has same dimension?	Work &power	**Momentum& impulse**	Force& torque	Torque and power
53)	If the force acting on body is doubled, then acceleration becomes	**Doubled**	Half	One fourth	Constant
54)	When the body moves with constant acceleration, the velocity time graph is	Parabola	Hyperbola	**Straight-line**	Curve
55)	Dimensional formula for impulse is	[MLT]	**$[MLT^{-1}]$**	$[MLT^{-2}]$	$[M^{-2}T^{-2}]$
56)	If the slope of velocity time graph remains constant then body is moving with	**Uniform acceleration**	Variable acceleration	Uniform velocity	Negative acceleration
57)	An object of mass 1Kg moving with acceleration $1ms^{-2}$ will experience force	10^{-2} N	10^{-3} N	**1 N**	1 dyne
58)	The velocity of projectile is maximum at	The highest point	**Point of launching and striking point**	At half of the height	After striking the ground
59)	The path followed by a projectile is known as	Range	**Trajectory**	Cycle	Height
60)	A ball is thrown up vertically, it takes 3 sec to reach maximum height, its initial velocity is	10 m/s	12.2 m/s	15 m/s	28.4 m/s
$a=\frac{Vf-Vi}{t} \Rightarrow g=\frac{0-Vi}{t} \Rightarrow -9.8=\frac{-Vi}{3} \Rightarrow Vi=28.4m/s$					
61)	The vertical velocity of ball thrown upward ___with time.	increase	**decrease**	Remains same	Zero
62)	A ball is thrown up with 20 m/s at angle of 60 with x-axis, the horizontal component of velocity is	0 m/s	**10 m/s**	20 m/s	16 m/s
Vix=VicosΘ=20cos60=20*0.5=10 m/s					
63)	If the mass of a body is doubled, then acceleration becomes	Double	**Half**	One fourth	Constant
64)	In the absence of external force, the change in momentum is	Zero	**Constant**	Decreasing	Increasing
65)	For which pair of angles, the range of projectile are equal	90°,20°	**70°,20°**	60°,40°	50°,10°
Equal rise and fall in 45 result into equal range, 45+25=70°, 45-25=20°					
66)	When average velocity becomes equal to instantaneous then body is called moving with	Instantaneous acceleration	**Constant velocity**	Variable velocity	Maximum and zero
67)	A car starts from rest and covers a distance of 100 m in one second	50 m/s^2	**200 m/s^2**	250 m/s^2	300 m/s^2

	with uniform acceleration, its acceleration				
$S = Vit + 1/2at^2 \Rightarrow 100 = 0 + 1/2(a)(1)^2 \Rightarrow a = 200m/s^2$					
68)	A body having uniform acceleration of 10 m/s^2 has a velocity of 100 m/s. in what time its velocity will be doubled?	8 Sec	**10 Sec**	12 Sec	14 Sec
Putting the given values in formula of acceleration $a = \frac{Vf - Vi}{t}$ so $t = \frac{Vf - Vi}{a} = \frac{200 - 100}{10} = 10$					
69)	At what speed the momentum and kinetic energy of body having the same value?	1 m/s	**2 m/s**	4 m/s	8 m/s
$P = mv,\ K.E = 1/2mv^2$, comparing equations to get result $mv = 1/2mv^2$, so V=2					
70)	Area under force time graph gives	**Impulse**	Velocity	Acceleration	Distance
71)	If a body is moving with constant velocity of 10 m/s , its acceleration is	1 ms-2	10 ms-2	30 ms-2	**Zero**
72)	The velocity of projectile at maximum height is	Vi	Zero	Maximum	**VicosΘ**
73)	In the presence of air friction, trajectory of high speed projectile	Elliptical path	Circular path	Spherical path	**Parabolic path**
74)	A mass of 5000gm produce an acceleration of 10 ms^{-2}, the force acting	**50 N**	5 N	20 N	10 N
Mass=m=5000gm=5000/1000 kg=5kg, a=10 ms-2, F=ma=5*10=50 N					
75)	The maximum range of projectile is 100km, take g=10ms-2, what must be initial velocity	**1km/s**	100 km/s	1000 km/s	100 m/s
R=100km, g=10 ms-2 vi=? Put these values in the formula of range of projectile to get the result					