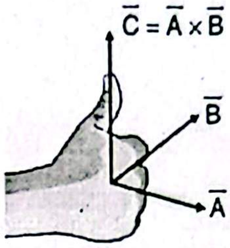
SHORT ANSWER QUESTIONS

2.1 State right hand rule for two vectors w.r.t. vector product.

Ans. **Direction of Vector Product:**



The direction of vector product $\vec{A} \times \vec{B}$ can be found by right hand rule.

Right hand Rule:

$$\boxed{\vec{A} \times \vec{B} = AB \sin\theta\,(\hat{n})}$$

Place the tails of vectors ($\vec{A}$) and ($\vec{B}$) together. Rotate 1st vector to 2nd vector through smaller possible angle.

- Curl of the fingers of the right hand to show rotation.
- Erected thumb represents the direction of ($\vec{A} \times \vec{B}$).

2.2 Define impulse and show how it is related to momentum.

Ans. **Impulse:**

The product of impulsive force and time is called impulse.

$$\vec{I} = \vec{F} \times t$$

As force is the time rate of change of momentum so

$$\vec{F} = \frac{m\vec{v}_f - m\vec{v}_i}{t}$$

Or

$$\vec{F} \times t = m\vec{v}_f - m\vec{v}_i$$

$$\vec{I} = m\vec{v}_f - m\vec{v}_i \qquad (\vec{I} = \vec{F} \times t)$$

$$\boxed{\vec{I} = \Delta\vec{P}}$$

So, impulse is equal to change in momentum.

2.3 Differentiate between an elastic and an inelastic collision.

Ans.

ELASTIC COLLISION	INELASTIC COLLISION
A collision in which kinetic energy of the system remain conserved, is called Elastic Collision.	A collision in which kinetic energy of the system is not conserved, is called Inelastic Collision.
$K.E_{(initial)} = K.E_{(final)}$	$K.E_{(initial)} \neq K.E_{(final)}$
It is an ideal case.	It is a real case.
Examples:	**Examples:**
• Bouncing back of the hard ball from marble floor.	• Collision between two tennis balls.
• Collision between atomic particles.	• Collision between two cars on the road.

Momentum & total Energy remains conserved in all types of collisions.

2.4 Show that rate of change in momentum is equal to force applied. Also state Newton's second law of motion in terms of momentum.

Ans. **Second Law in Terms of Momentum:**

Time rate of change of momentum of body is equal to the applied force.

Let body of mass m moving with initial velocity $\vec{v}_i$, when force F is applied then final velocity become $\vec{v}_f$ in time t.

Then $\qquad \vec{a} = \dfrac{\vec{v}_f - \vec{v}_i}{\Delta t}$

According to Newton's second law of motion,

$$\vec{F} = m\,\vec{a} = m\frac{(\vec{v}_f - \vec{v}_i)}{t} = \frac{m\Delta\vec{v}}{t}$$

$$\boxed{\vec{F} = \frac{\Delta\vec{P}}{t}}$$

It is general form of Newton's 2nd law in terms of momentum

2.5 State law of conservation of linear momentum. Also state condition under which it holds.

Ans. Law of Conservation of Momentum:

Total linear momentum of an isolated system always remains constant.

➢ $\qquad P = constant \quad \Rightarrow \quad \Delta P = 0$

Condition for hold:

- Law of conservation of momentum holds only for isolated systems otherwise it is not valid.
- When the external force is very small (negligible) as compare to the force between the interacting bodies, this law is fulfilled even though the system is not completely isolated.

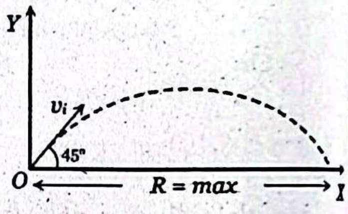
2.6 Show that range of projectile is maximum at an angle of 45°.

Ans. As range of the projectile can be expressed as:

$$R = \frac{v_i^2 \sin 2\theta}{g}$$

For maximum range of the projectile:

$$\begin{aligned} \sin 2\theta &= 1 \text{ (as '1' is max value)} \\ 2\theta &= \sin^{-1}(1) \\ 2\theta &= 90^\circ \\ \theta &= 90^\circ/2 \\ \boxed{\theta} &\boxed{= 45^\circ} \end{aligned}$$



The horizontal range of a projectile is maximum when it is projected at an angle of 45° with the horizontal.

2.7 Find the time of flight of a projectile to reach the maximum height.

Ans. From first equation of motion

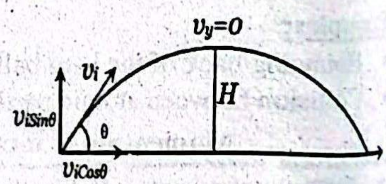
$$v_f = v_i + at$$

To find maximum height of the projectile:

For vertical, $\quad v_f = v_{fy} = 0 \quad v_i = v_{iy} = v_i \sin\theta, \quad a = a_y = -g$

so,

$$\begin{aligned} v_{fy} &= v_{iy} + a_y t \\ 0 &= v_i \sin\theta - gt \\ gt &= v_i \sin\theta \\ \boxed{t} &\boxed{= \frac{v_i \sin\theta}{g}} \end{aligned}$$



2.8 The maximum horizontal range of a projectile is 800 m. find the value of height attained by the projectile at θ = 60°.

Ans: We know the formula of maximum horizontal range is:

$$R_{max} = \frac{v_i^2}{g} = 800\,m$$

Now, the formula of height is:

$$H = \frac{v_i^2 \sin^2\theta}{2g} = \left(\frac{v_i^2}{g}\right)\left(\frac{\sin^2\theta}{2}\right) \text{ ------ (i)}$$

Putting values in equation (i):

$$H = (800)\left(\frac{\sin^2(60^\circ)}{2}\right)$$

$$H = \frac{(800)(0.866)^2}{2} \qquad \text{Where: } \sin 60^\circ = 0.866$$

$$H = 400(0.75)$$

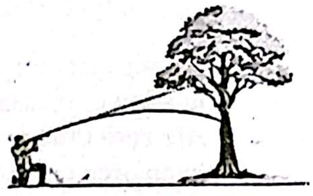
$$\boxed{H = 300\,m}$$

The height attained by the projectile is 300 m.

CONSTRUCTED RESPONSE QUESTIONS

2.1 Why does a hunter aiming a bird in a tree miss the target exactly at the bird?

Ans. A hunter misses a bird in a target due to **curved path due to gravity.**



Explanation:

When the bullet is fired, it moves forward but also **accelerates downward due to gravity.** As a result, its path becomes **curved,** instead of straight path.

To hit the target, the hunter must **aim slightly above the target** to hit the bird.

2.2 A person falling on a heap of sand does not hurt more as compared to a person falling on a concrete floor. Why?

Ans. A person falling on a heap of sand is less hurt as sand increase the time of collision to reduce the force.

Explanation:

$$F = \frac{\Delta P}{t} \Rightarrow F \propto \frac{1}{t}$$

- A person falls on sand the time of impact increases which reduces effect of force that's why he doesn't get hurt.
- On falling on the concrete floor will time of collision is less, therefore more impulsive force F causes more hurt.

2.3 State the conditions under which birds fly in air.

Ans. Birds fly when (Lift ≥ Weight) and (Forward force > Drag force)

Explanation:

Lift Force Greater Than Weight:

The bird must generate enough lift (an upward force) to overcome its weight (gravity pulling it down).

Thrust to Overcome Drag:

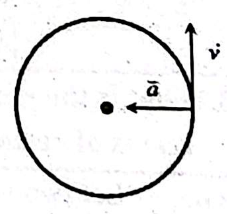
Birds must produce thrust (forward force) using their wing movements to overcome air resistance (drag).

2.4. Describe the circumstances for which velocity and acceleration of a vehicle are:
(i) *v* is zero but *a* is not zero (ii) *a* is zero but *v* is not zero (iii) perpendicular to one another

Ans. (i) $\vec{v}$ is Zero but $\vec{a}$ is not Zero:

When moving vehicle is ***stopped by applying sudden brakes*** then v is zero but a is not zero.

(ii) $\vec{a}$ is Zero but $\vec{v}$ is not Zero:



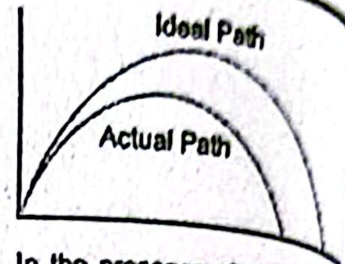
When vehicle moves with ***uniform*** velocity then $\vec{v}$ is not zero but $\vec{a}$ is zero.

(iii) Perpendicular to Each Other:

If the vehicle is moving in a <u>***circular path***</u> then the velocity $\vec{v}$ and acceleration $\vec{a}$ are mutually perpendicular.

2.5. Describe briefly effects of air resistance on the range and maximum height of a projectile.

Ans. Presence of air decreases the range and the maximum height of a projectile.



In the presence of air friction the trajectory of a high speed projectile falls short of a parabolic path

Explanation:

Range of the projectile can be expressed as:

$$R = \frac{v_i^2 \sin 2\theta}{g} \Rightarrow (R \propto v_i^2)$$

Air resistance slows down the horizontal component of velocity. As a result, the projectile covers less horizontal distance.

Height of the projectile can be expressed as:

$$H = \frac{v_i^2 \sin\theta^2}{2g} \Rightarrow (H \propto v_i^2)$$

Air resistance opposes the vertical motion of a projectile, quickly reducing its vertical velocity and resulting in a lower maximum height.

Air resistance reduces a projectile's **range** and **maximum height**, making it travel **shorter** and **lower** than in air-free conditions.