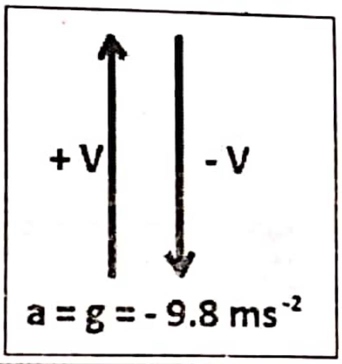
SHORT QUESTIONS

Write short answers of the following questions.

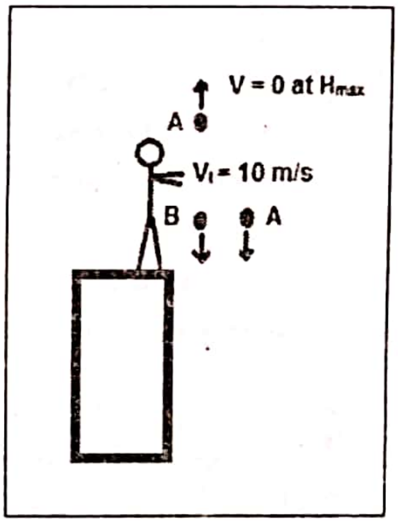
1. Can the velocity of a body reverse the direction when acceleration is constant? If you think so, give an example.

Ans. Yes, when a body is thrown upward, the direction of its linear velocity is also upward ($+\vec{V}$). After reaching its maximum height the direction of linear velocity becomes downward ($-\vec{V}$), but throughout this motion acceleration of the body will remain constant and equal to $g = -9.8\ m/s^2$.



2. A man standing on the top of a tower throws a ball vertically up with certain velocity. He also throws another ball vertically down with the same speed. Which ball will hit the ground with higher speed? Neglect air resistance.

Ans. Both balls will hit the ground with same speed. Consider the man standing on the top of the tower as shown in the figure. The man throws a ball A with a velocity of 10 m/s upward and a ball B with a velocity of 10 m/s downward. The ball A continues its upward journey and at point of maximum height its velocity becomes zero. Now when it reaches its point of projection, its velocity is again 10 m/s because it has fallen through the same height. Since the ball B was also thrown with a velocity of 10 m/s downward, so both balls will hit the ground with same velocity but at different times.



4. Motion with constant velocity is a special case of motion with constant acceleration. Is this statement true? Discuss.

Ans. In mathematical language the motion with constant velocity is a special case of motion with constant acceleration. Acceleration is said to be constant if its value neither increases nor decreases but remains constant. Since zero is also a constant value so we can say that $a = 0$ is also a special case of motion with constant acceleration. e.g., in projectile motion V_x = constant and therefore $a_x = 0$ = constant. Such type of motion is always constant or uniformly accelerated motion.

5. Define impulse and state how it is related to linear momentum?

Ans. **Impulse:**

The product of very large amount of force that acts upon the body for a very short interval of time Δt is called impulse.

Mathematically Impulse, $\vec{I} = \vec{F}.\Delta t$

<u>Relation between Impulse and Linear Momentum</u>

According to Newton's 2nd law of motion

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

Or

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

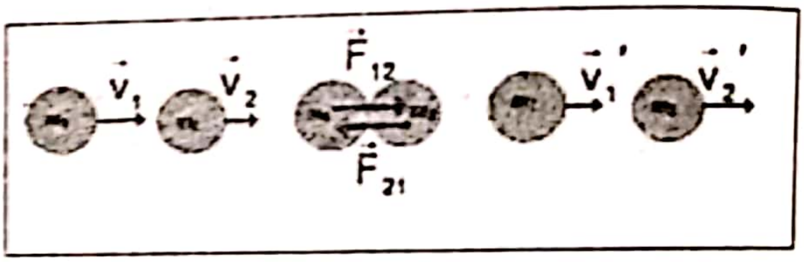
$$\vec{I} = \Delta\vec{P} \qquad (\vec{I} = \vec{F}.\Delta t)$$

Hence impulse is equal to the change in the linear momentum of a body.

6. What is head – on collision? Explain with an example.

Ans. Head-on collision

If the centers of the colliding bodies keep moving along the same straight line even after collision, the collision is said to be Head-on collision.



Let an incident spherical object of mass m_1, moving with a velocity V_1 along X-axis, strikes another spherical object of mass m_2 moving with velocity V_2. We suppose that V_2 is less than V_1. After some time interval, a head-on collision takes place along the x-axis, as shown in figure above and the masses will continue to move along the same line along x-axis.

7. For any specific velocity of projection, the range of a projectile cannot exceed from a value equal to four times of the corresponding height. Discuss.

Ans. The range of projectile is given by;

$$R = V_i^2 \frac{\text{Sin}2\theta}{g} \qquad (1)$$

The height reached by projectile is given by;

$$H = V_i^2 \frac{\text{Sin}^2\theta}{2g} \qquad (2)$$

From given statement, it follows that;

$$R = 4\,H \qquad (3)$$

Putting values from Eq.1 and Eq.2, in Eq.3, we get;

$$V_i^2 \frac{\text{Sin}2\theta}{g} = 4\,V_i^2 \frac{\text{Sin}^2\theta}{2g}$$

$$\text{Sin}\,2\theta = 2\,\text{Sin}^2\theta$$

$$2\,\text{Sin}\,\theta\,\text{Cos}\,\theta = 2\,\text{Sin}^2\theta \qquad (\text{Sin}\,2\theta = 2\,\text{Sin}\theta\,\text{Cos}\theta)$$

$$\text{Cos}\,\theta = \text{Sin}\,\theta$$

$$\text{Sin}\,\theta/\,\text{Cos}\,\theta = 1$$

$$\tan\theta = 1$$

$$\theta = \tan^{-1}(1) = 45^\circ$$

This shows that for a specific angle of projection $\theta = 45^\circ$, the range become four times of the corresponding height.

8. What is the angle for which the maximum height reached and corresponding range are equal?

Ans. The angle of projection for which the maximum height reached and corresponding range are equal is calculated as follow:

The range of projectile is given by;

$$R = V_i^2 \frac{\text{Sin}2\theta}{g} \qquad (1)$$

The height reached by projectile is given by;

$$H = V_i^2 \frac{\text{Sin}^2\theta}{2g} \qquad (2)$$

From given statement, it follows that;

$$R = H \qquad (3)$$

Putting values from Eq.1 and Eq.2, in Eq.3, we get;

$$V_i^2 \frac{\text{Sin}2\theta}{g} = V_i^2 \frac{\text{Sin}^2\theta}{2g}$$

$$\text{Sin}\,2\theta = \text{Sin}^2\theta/2$$

$$2\,\text{Sin}\,\theta\,\text{Cos}\,\theta = \text{Sin}^2\theta/2 \quad (\text{Sin}2\theta = 2\,\text{Sin}\,\theta\,\text{Cos}\,\theta)$$

$$2\,\text{Cos}\,\theta = \text{Sin}\,\theta/2$$

$$\text{Sin}\,\theta/\,\text{Cos}\,\theta = 4$$

$$\tan\theta = 4$$

$$\theta = \tan^{-1}(4) = 75.96^\circ = 76^\circ$$

9. An aeroplane while horizontally drops a bomb when reaches exactly above the target, but missed it. Explain.

Ans. The bomber misses the target due to horizontal component of its velocity. The bomb in the aeroplane has exactly the same horizontal speed as that of aeroplane. When the aeroplane drops the bomb, the bomb will continue its horizontal motion due to inertia and hence will move far away from its target and therefore miss it.