

Force and Law s of Motion: In-Text Questions

[Page 118]

Q.1 Which of the following has more inertia:

- (a) a rubber ball and a stone of the same size?
- (b) a bicycle and a train?
- (c) a five rupees coin and a one-rupee coin?

Sol. (a) A stone.
(b) A train
(c) A five rupees coin.

Explanation: Objects with more mass have more inertia because inertia is associated with mass.

Q.2 In the following example, try to identify the number of times the velocity of the ball changes:

“A football player kicks a football to another player of his team who kicks the football towards the goal. The goalkeeper of the opposite team collects the football and kicks it towards a player of his own team”. Also identify the agent supplying the force in each case.

Sol. In the above example, the velocity of football changes four times. Firstly, when a football player kicks to another player, here agent is football player, second when that player kicks the football to the goalkeeper here agent is second football player. Third, when the goalkeeper stops the football, here agent is goal keeper. Fourth when the goalkeeper kicks the football towards a player of his own team, here agent is also goal keeper.

Q.3 Explain why some of the leaves may get detached from a tree if we vigorously shake its branch.

Sol. When the tree is shaken vigorously, the tree comes in motion while leaves have the inertia of rest, so leaves remain at rest position. Thus, due to remaining in the position of rest some of the leaves get detached from the tree.

Q.4 Why do you fall in the forward direction when a moving bus brakes to a stop and fall backwards when it accelerates from rest?

Sol. A passenger in moving bus, both are in motion. When suddenly brakes are applied to stop the bus, the bus comes in the position of rest. But the passenger has the tendency to be in motion due to inertia of motion, passenger falls in the forward direction. Similarly, when a bus suddenly starts from rest, the passenger has the tendency to be at rest due to inertia of rest, the passenger in the bus falls backward.

Q.1 If action is always equal to the reaction, explain how a horse can pull a cart.

Sol. When horse pulls the cart, it pushes the ground in backward direction. In reaction to this, the horse moves forward along with cart in forward direction. In this situation, when horse tries to pull the cart in forward direction, cart also pulls the horse in backward direction according to Newton's third law, but due to the unbalanced force applied by the horse, it pulls the cart in forward direction.

Q.2 Explain, why is it difficult for a fireman to hold a hose, which ejects large amounts of water at a high velocity.

Sol. When water in large amount is ejected from a hose at a high velocity, according to Newton's Third Law of Motion, it applies same force and pushes the hose in backward direction. This, it is very difficult for a fireman to hold a hose, which ejects large amount of water at a high velocity.

Q.3 From a rifle of mass 4 kg, a bullet of mass 50 g is fired with an initial velocity of 35 m/s. calculate the initial recoil velocity of the rifle.

Sol. Given: Mass of rifle $m_1 = 4$ kg
Initial velocity of rifle $u_1 = 0$
Mass of bullet $m_2 = 50$ g = $50/1000$ kg = 0.05 kg
Initial velocity of bullet $u_2 = 0$
Final velocity of bullet $V_2 = 35$ m/s
Final velocity of rifle $v_1 = ?$

According to law of conservation of momentum:

Initial Momentum = final momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$0 = 4 \times v_1 + 0.05 \times (-35)$$

$$4 \times v_1 = 0.05 \times 35$$

$$V_1 = 0.4375 \text{ m/s}$$

Recoil velocity of rifle = 0.4375 m/s

Q.4 Two objects of masses 100 g and 200 g are moving along the same line and direction with velocities of 2 m/s and 1 m/s, respectively. They collide and after the collision, the first object moves at a velocity of 1.67 m/s. determine the velocity of the second object.

Sol. Given: Mass of first object $m_1 = 100$ g = $100/1000$ kg = 0.1 kg
Initial velocity of first object $u_1 = 2$ m/s
Final velocity of first object after collision $v_1 = 1.67$ m/s
Mass of second object $m_2 = 200$ g = $200/1000$ kg = 0.2 kg
Initial velocity of second object $u_2 = 1$ m/s
Final velocity of second object after collision $v_2 = ?$

According to law of conservation of momentum:

Initial Momentum = final momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$(0.1 \times 2) + (0.2 \times 1) = (0.1 \times 1.67) + (0.2 \times V_2)$$

$$0.2 + 0.2 = 0.167 + 0.2 v_2$$

$$V_2 = 0.233/0.2 = 1.165 \text{ m/s}$$

Thus, the velocity of second object is 1.165 m/s