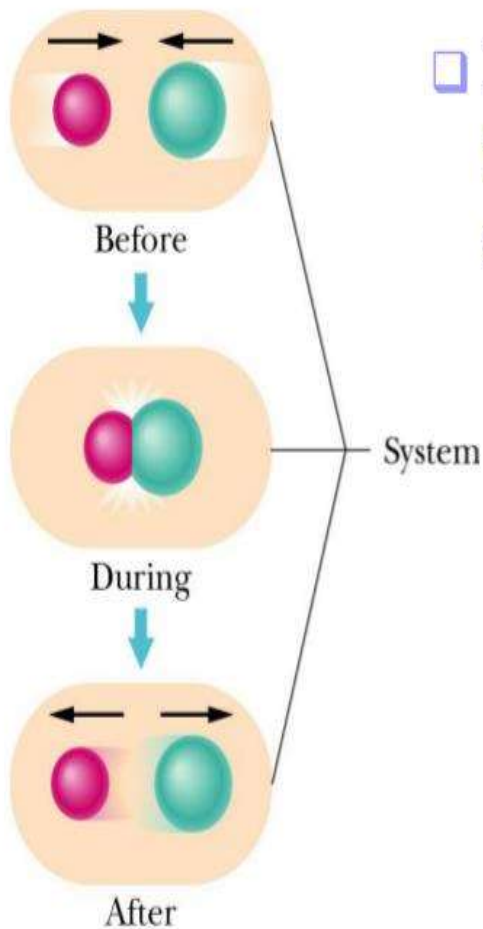


FORCE AND LAWS OF MOTION

CLASS 9
MODULE 5/5

CONSERVATION OF MOMENTUM

Conservation of Momentum



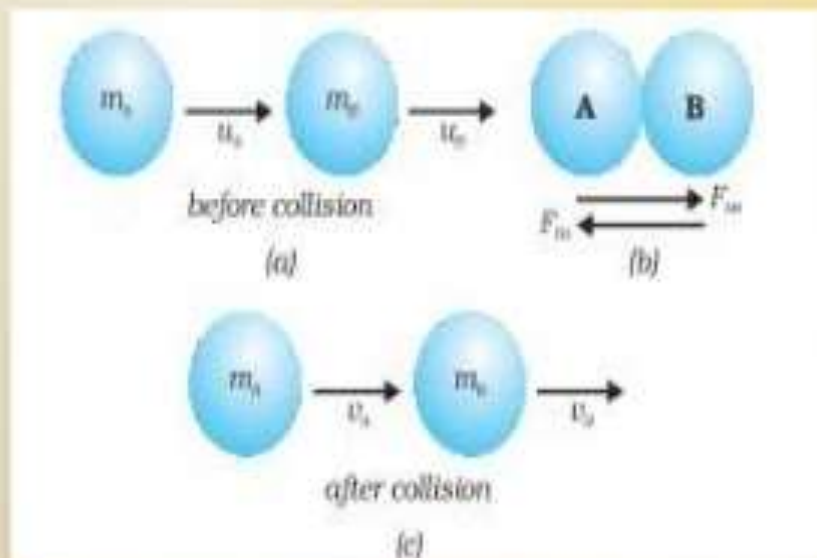
- In an isolated and closed system, the total momentum of the system remains constant in time.
 - Isolated system: no external forces
 - Closed system: no mass enters or leaves
 - The linear momentum of each colliding body may change
 - The total momentum P of the system cannot change.

The Law of Conservation of Momentum

The sum of the momenta of the two objects before collision is equal to the sum of momenta after the collision provided there is no external unbalanced force acting on them.

Collision of two balls

According to the third law of motion, the force F exerted by ball A on ball B (action) and the force F exerted by the ball B on ball A (reaction) must be equal and opposite to each other.



$$F_{AB} = -F_{BA}$$

or

$$m_A \frac{(v_A - u_A)}{t} = -m_B \frac{(v_B - u_B)}{t}$$

This gives,

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

So, the total momentum of the two balls remains unchanged or conserved provided no other external force acts.

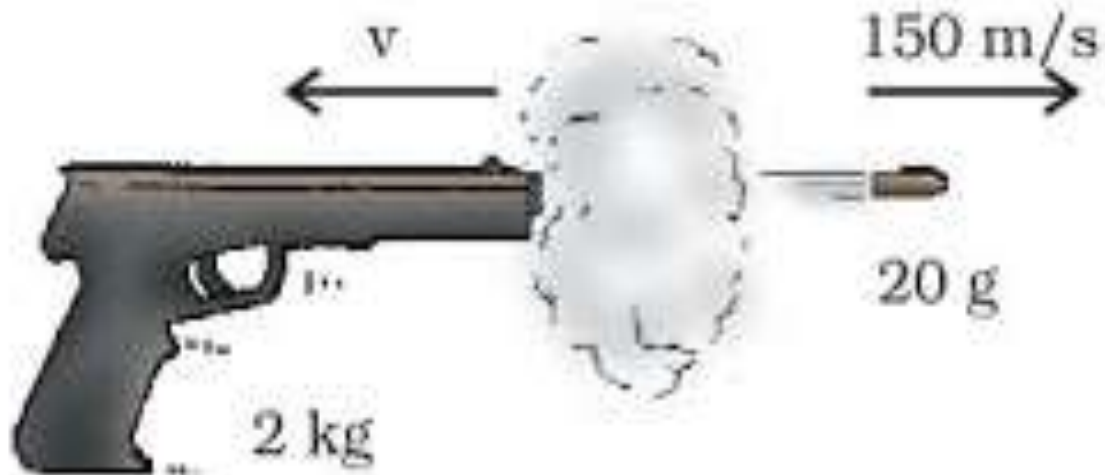
Example :

before firing



(a)

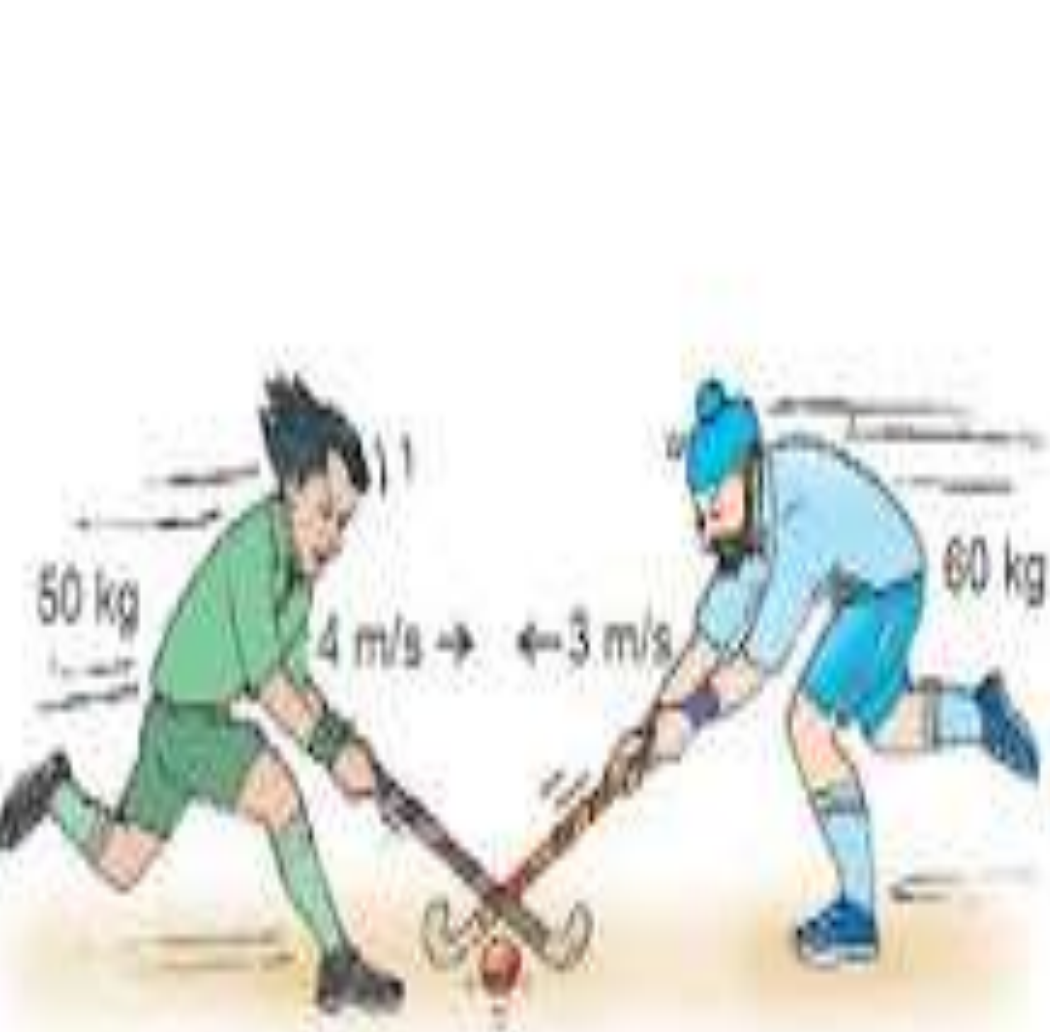
after firing



(b)

Recoil of a pistol

1) Two hockey players of opposite teams, while trying to hit a hockey ball on the ground collide and immediately collide. One has mass of 60 kg and moving with a velocity 5 m/s while the other has a mass of 55 kg and was moving faster with a velocity 6 m/s towards the first player. In which direction and with what velocity will they move after they collide? Assume the frictional force acting between the feet of the two players and the ground is negligible.



(a)



(b)

A collision of two hockey players: (a) before collision and (b) after collision.

Ans :- $m_1 = 60 \text{ kg}$ $u_1 = + 5 \text{ m/s}$

$m_2 = 55 \text{ kg}$ $u_2 = - 6 \text{ m/s}$

The total momentum of the two players before the collision = $60 \text{ kg} \times (+ 5 \text{ m/s}) + 55 \times (-6 \text{ m/s})$

= $- 30 \text{ kg m/s}$

Let v be the final velocity after collision

After Collision, the total momentum

= $(m_1 + m_2) v = (60 + 55) \text{ kg} \times v \text{ m/s}$

= $115v \text{ kg m/s}$

Using the law of conservation of the momentum :

$115v = - 30$

$v = - 30/115$

$v = - 0.26 \text{ m/s}$

2) An object of mass 100 kg is accelerated uniformly from a velocity of 5 m/s to 8 m/s in 6 s. Calculate the initial and final momentum of the object. Also, find the magnitude of the force exerted on the object.

Ans. $m = 100 \text{ kg}$, $u = 5 \text{ m/s}$, $v = 8 \text{ m/s}$, $t = 6 \text{ s}$

$$p_1 = ? \quad p_2 = ? \quad F = ?$$

Initial momentum $p_1 = mu = 100 \times 5 = 500 \text{ kg m/s}$

Final momentum $p_2 = mv = 100 \times 8 = 800 \text{ kg m/s}$

Force exerted on the object $F = ma$

$$= m(v-u)/t$$

$$= 100 \text{ kg} \times (8-5)/6$$

$$= 50 \text{ N.}$$



THANK YOU