ST. LAWRENCE HIGH SCHOOL

A JESUIT CHRISTIAN MINORITY INSTITUTION

- **Subject- Physics Study Material -2 Class IX**
- **Date : 5.05.2020**
- **Chapter: Force and Motion**

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

Ans. The third law of motion states that action is always equal to the reaction but they act on two different bodies.

In this case the horse exerts a force on the ground with its feet while walking, the ground exerts an equal and opposite force on the feet of the horse, which enables the horse to move forward and the cart is pulled by the horse.

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

Ans. The water that is ejected out from the hose in the forward direction comes out with a large momentum and equal amount of momentum is developed in the hose in the opposite direction and hence the hose is pushed backward. It becomes difficult for a fireman to hold a hose which experiences this large momentum.

Q. 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.

Ans. (m_1) Mass of rifle = 4 kg

(m_2) Mass of bullet = 50 g = 0.05 kg

(v_2) Velocity of bullet = 35 m/s

(v_1) Recoil velocity of rifle = ?

According to the law of conservation of momentum

Momentum of rifle = momentum of bullet

$m v = MV$

$v = 0.05 \times 35 / 4$

$=0.43$ m/s

Q. 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.

Ans. $m_1 = 100\ g = 0.1\ kg$

$m_2 = 200\ g = 0.2\ kg$

$u_1 = 2\ m/s$

$u_2 = 1\ m/s$

After collision

$v_1 = 1.67\ m/s$

$v_2 = ?$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Q.An object experiences a net zero external unbalanced force. Is it possible for the object to be travelling with a non-zero velocity? If yes, state the conditions that must be placed on the magnitude and direction of the velocity. If no, provide a reason.

Ans. When an object experiences a net zero external unbalanced force, in accordance with second law of motion its acceleration is zero. If the object was initially in a state of motion, then in accordance with the first law of motion, the object will continue to move in same direction with same speed. It means that the object may be travelling with a non-zero velocity but the magnitude as well as direction of velocity must remain unchanged or constant throughout.

Q. When a carpet is beaten with a stick, dust comes out of it. Explain.

Ans. The carpet with dust is in state of rest. When it is beaten with a stick the carpet is set in motion, but the dust particles remain at rest. Due to inertia of rest the dust particles retain their position of rest and falls down due to gravity.

Q. Why is it advised to tie any luggage kept on the roof of a bus with a rope?

Ans. In moving vehicle like bus, the motion is not uniform, the speed of vehicle varies and it may apply brake suddenly or takes sudden turn. The luggage will resist any change in its state of rest or motion, due to inertia and this luggage has the tendency to fall sideways, forward or backward.

To avoid the fall of the luggage, it is tied with the rope.

Q. A batsman hits a cricket ball which then rolls on a level ground. After covering a short distance, the ball comes to rest. The ball slows to a stop because

(a) the batsman did not hit the ball hard enough,

(b) velocity is proportional to the force exerted, on the ball.

(c) there is a force on the ball opposing the motion.

(d) there is no unbalanced force on the ball, so the ball would want to come to rest.

Ans. (c) there is a force on the ball opposing the motion.

Q. A 8000 kg engine pulls a train of 5 wagons, each of 2000 kg, along a horizontal track. If the engine exerts a force of 40000 N and the track offers a friction force of 5000 N, then calculate:

(a) the net accelerating force;

(b) the acceleration of the train; and

(c) the force of wagon 1 on wagon 2.

Ans. (a) The net accelerating force = Force exerted by the engine – friction force

= 40000 N – 5000 N = 35000 N

= 35000 N

(b) The acceleration of the train (a) = ?

F = 35000 N

Mass of 5 wagons pulled by engine

= 5 × 2000

= 10000 kg

F = ma

35000 = 10000 × a

a = 35000÷10000 = 3.5 m per second square .

(c) The force of wagon 1 on wagon 2

F = ?

Mass of wagon 2 → (2000 × 4)

a = 3.5 m/s^2

F = ma

= 8000 × 3.5

= 28000 N

Q. An automobile vehicle has a mass of 1500 kg. What must be the force between the vehicle and road if the vehicle is to be stopped with a negative acceleration of 1.7 ms–2?

Ans. mass = 1500 kg

a = –1.7 m/s^2

F = ?

F = m × a

= 1500 × (– 1.7)

= – 2550 N

The force between the vehicle and road is – 2550 N.

Q. Two objects each of mass 1.5 kg, are moving in the same straight line but in opposite directions. The velocity of each object is 2.5 ms–1 before the collision during which they stick together. What will be the velocity of the combined object after collision?

Ans. Mass of the objects m1 = m2 = 1.5 kg

Velocity of first object v_1 = 2.5 m/s

Velocity of second object v_2 = – 2.5 m/s

Momentum before collision = $m_1v_1 = m_2v_2$

= (1.5 × 2.5) + (1.5 × –2.5) = 0

Momentum after collision = $m_1 + m_2$ = 1.5 + 1.5 = 3.0 kg

After collision v = ?

According to law of conservation of momentum

Momentum before collision = Momentum after collision

0 = 3 × v

v = 0

Q. According to the third law of motion when we push on an object, the object pushes back on us with an equal and opposite force. If the object is a massive truck parked along the roadside, it will probably not move. A student justifies this by answering that the two opposite and equal forces cancel each other. Comment on this logic and explain why the truck does not move.

Ans. The mass of truck is too large and hence its inertia is too high. The small force exerted on the truck cannot move it and the truck remains at rest. For the truck to attain motion, an external large amount of unbalanced force need to be exerted on it.

Q. A hockey ball of mass 200 g travelling at 10 ms–1 is struck, by a hockey stick so as to return it along its original path with a velocity at 5 ms–1. Calculate the change of momentum occurred in the motion of the hockey ball by the force applied by the hockey stick.

Ans. Mass of ball m = 200 g = 0.2 kg

Initial speed of ball u = 10 m/s

Final speed of ball v = – 5 m/s

Initial momentum of the ball = mu

= 0.2 kg x 10 m/s

= 2 kg m/s

Final momentum of the ball = mv

= 0.2 kg x (_ 5 m/s)

= – 1 kg m/s

Hence, change in momentum= Difference in the momentum

=2 – (–1)

= 2 + 1 = 3kg m/s

Q An object of mass 1 kg travelling in a straight line with a velocity of 10 msr' collides with, and sticks to, a stationary wooden block of mass 5 kg. Then they both move off together in the same straight line. Calculate the total momentum just before the impact and just after the impact. Also, calculate the velocity of the combined object.

Ans. m_1 = 1 kg

v_1 = 10 m/s

Mass of wooden block = 5 kg

m_2 = 5 kg + 1 kg (combined object) = 6 kg

Velocity of combined object = v_2 = ?

p_1 and p_2 = ?

Momentum before impact p = m_1v_1

= 1 × 10 = 10 kg m/s

∴ Momentum before impact= Momentum after impact

Q. An object of mass 100 kg is accelerated uniformly from a velocity of 5 ms^{-1} to 8 ms^{-1} 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 kg

u = 5 m/s

v = 8 m/s

t = 6s

p_1 = ?

p_2 = ?

F = ?

Initial momentum p_1 = mu

= 100 × 5 = 500 kg m/s

Final momentum p_2 = mv

= 100 × 8 = 800 kg m/s

Force exerted on the object F = ma =100×(8-5÷6)

=100×0.5 =50 N

Teacher- Piyali Halder