

CHAPTER 8

FORCE AND LAWS OF MOTION

VEDA
ACADEMY

CLASS 9TH

NCERT EXERCISE AND SOLUTIONS - SCIENCE



P1



P2

Q. 1. 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.

ANSWER:-

Yes, it's possible for an object to be moving with a non-zero velocity even when there is no net unbalanced force acting on it. This happens when the object is already moving at a constant velocity in a specific direction. In such a case, there is no unbalanced force acting on it, so it continues moving with that velocity. To change its motion (speed or direction), a net unbalanced force must be applied to the object.

Q. 2. When a carpet is beaten with a stick, dust comes out of it, Explain.

ANSWER:-

Inertia is the property of an object that resists any change in its state of rest or motion. When a carpet is beaten with a stick, the carpet starts moving. However, the dust particles on the carpet resist this change and try to stay at rest. According to Newton's first law of motion, the dust particles continue to stay at rest while the carpet moves. As a result, the dust particles are shaken off the carpet.

Q. 3. Why is it advised to tie any luggage kept on the roof of a bus with a rope?

ANSWER:-

When a bus accelerates forward, it starts moving. However, the luggage on the roof, due to its inertia, wants to stay at rest. As the bus moves forward, the luggage resists the change in motion and tries to stay in its original position. Eventually, the luggage falls off the roof. To prevent this, it's important to tie the luggage securely with a rope.

Q. 4. 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.



ANSWER:-

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

A ball slows to a stop because of an unbalanced force acting against its direction of motion. This primary force is friction from the ground and some air resistance. According to Newton's First Law, an object in motion will stay in motion unless acted upon by a force, so the ball's stopping is evidence that a force is indeed acting on it.

- Q. 5. A truck starts from rest and rolls down a hill with a constant acceleration. It travels a distance of 400 m in 20 s. Find its acceleration. Find the force acting on it if its mass is 7 tonnes. (Hint: 1 tonne.)**

ANSWER:-

Given: Initial velocity of the truck, $u = 0$ m/s, Time taken, $t = 20$ s, Distance covered by the stone, $s = 400$ m, Mass of the truck, $m = 7000$ kg

Need to find: Acceleration and Force

Finding acceleration (a):

Using the second equation of motion:

$$s = ut + \frac{1}{2}at^2$$

Substitute the given values:

$$400 = 0 \times 20 + \frac{1}{2} \times a \times (20)^2$$

Simplifying:

$$400 = 200a$$

$$a = \frac{400}{200} = 2 \text{ m/s}^2$$

Using the formula for force:

$$F = \text{mass} \times \text{acceleration}$$

Substitute the given values:

$$F = 7000 \times 2 = 14,000 \text{ N}$$

- Q. 6. A stone of 1 kg is thrown with a velocity of 20 m s^{-1} across the frozen surface of a lake and comes to rest after travelling a distance of 50 m. What is the force of friction between the stone and the ice?**

ANSWER:-

Given- Initial velocity of the stone, $u = 20$ m/s, Final velocity of the stone, $v = 0$ m/s

Distance covered by the stone, $s = 50$ m, Mass of the stone, $m = 1$ kg

Need to find- Acceleration and Force

Finding acceleration (a):

Using the third equation of motion:

$$v^2 = u^2 + 2as$$



Substitute the given values:

$$0^2 = 20^2 + 2 \times a \times 50$$

Simplifying:

$$0 = 400 + 100a$$

$$100a = -400$$

$$a = \frac{-400}{100} = -4 \text{ m/s}^2$$

The negative sign indicates that the acceleration is acting opposite to the motion of the stone (i.e., decelerating the stone).

Using Newton's second law of motion:

$$F = \text{Mass} \times \text{Acceleration}$$

Substitute the given values:

$$F = 1 \times (-4) = -4 \text{ N}$$

Q. 7. 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:

- the net accelerating force and
- the acceleration of the train.

ANSWER:-

(a) Given: Force exerted by the engine $F = 40,000 \text{ N}$, Frictional force offered by the track $F_f = 5,000 \text{ N}$

$$\text{Net accelerating force: } F_a = F - F_f = 40,000 - 5,000 = 35,000 \text{ N}$$

Hence, the net accelerating force is 35,000 N.

(b) Given: Mass of a wagon = 2,000 kg, Number of wagons = 5, Total mass of the wagons $m = 2,000 \times 5 = 10,000 \text{ kg}$ Mass of the engine = 8,000 kg

$$\text{Total mass (including the engine) } M = 10,000 + 8,000 = 18,000 \text{ kg}$$

$$\text{Net accelerating force } F_a = 35,000 \text{ N}$$

To find acceleration:

$$\text{Using } F_a = Ma:$$

$$a = \frac{F_a}{M} = \frac{35,000}{18,000} = 1.944 \text{ m/s}^2$$

Hence, the acceleration of the train is 1.944 m/s².

Q. 8. 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 m s⁻²?

ANSWER:-

Mass of the automobile vehicle, $m = 1500 \text{ kg}$

Final velocity, $v = 0 \text{ m/s}$

Acceleration of the automobile, $a = -1.7 \text{ ms}^{-2}$



From Newton's second law of motion:

$$\text{Force} = \text{Mass} \times \text{Acceleration} = 1500 \times (-1.7) = -2550 \text{ N}$$

Hence, the force between the automobile and the road is -2550 N, in the direction opposite to the motion of the automobile.

Q. 9. What is the momentum of an object of mass , moving with a velocity ?

- (a) $(mv)^2$
- (b) mv^2
- (c) $1/2mv^2$
- (d) mv

ANSWER:-

- (d) mv

Mass of the object = m

Velocity = v

Momentum = Mass \times Velocity

Momentum = mv

Q. 10. Using a horizontal force of 200 N, we intend to move a wooden cabinet across a floor at a constant velocity. What is the friction force that will be exerted on the cabinet?

ANSWER:-

When a force of 200 N is applied in the forward direction on the cabinet, according to Newton's third law of motion, an equal and opposite force will be exerted by the cabinet on whatever is applying the force. In this case, the equal and opposite force is the frictional force that resists the motion of the cabinet. Therefore, a frictional force of 200 N is exerted on the cabinet in the opposite direction to the applied force.

Q. 11. 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.

ANSWER:-

The student's logic is incorrect. The two forces do not cancel each other out because they act on different objects (you and the truck), not on the same object. According to Newton's Third Law, forces in an action-reaction pair always act on separate bodies.

The truck doesn't move because the force you apply to it is opposed by an equal and opposite force of static friction from the ground. The truck will only move when your pushing force exceeds this frictional force.



Q. 12. A hockey ball of mass 200 g travelling at 10 m s^{-1} is struck by a hockey stick so as to return it along its original path with a velocity at 5 m s^{-1} . Calculate the magnitude of change of momentum occurred in the motion of the hockey ball by the force applied by the hockey stick.

ANSWER:-

Given: Mass of the hockey ball, $m = 200 \text{ g} = 0.2 \text{ kg}$, Initial velocity of the hockey ball, $v_1 = 10 \text{ m/s}$, Final velocity of the hockey ball (opposite direction), $v_2 = -5 \text{ m/s}$

Initial momentum

Momentum is given by the formula $p = mv$, where p is momentum, m is mass, and v is velocity.

So, initial momentum:

$$\text{Initial momentum} = m \times v_1 = 0.2 \times 10 = 2 \text{ kg}\cdot\text{m/s}$$

$$\text{Final momentum} = m \times v_2 = 0.2 \times (-5) = -1 \text{ kg}\cdot\text{m/s}$$

The change in momentum is the difference between final and initial momentum:

$$\text{Change in momentum} = \text{Final momentum} - \text{Initial momentum} = -1 - 2 = -3 \text{ kg}\cdot\text{m/s}$$

Hence, the change in momentum of the hockey ball is $3 \text{ kg}\cdot\text{m/s}$ (in the opposite direction of initial

Q. 13. A bullet of mass 10 g travelling horizontally with a velocity of 150 m s^{-1} strikes a stationary wooden block and comes to rest in 0.03 s. Calculate the distance of penetration of the bullet into the block. Also calculate the magnitude of the force exerted by the wooden block on the bullet.

ANSWER:-

Given- Initial velocity of the bullet, $u = 150 \text{ m/s}$, Final velocity of the bullet, $v = 0 \text{ m/s}$ (because the bullet comes to rest), Time taken to come to rest, $t = 0.03 \text{ s}$, Mass of the bullet, $m = 10 \text{ g} = 0.01 \text{ kg}$

Need to find- distance of penetration

Using the first equation of motion:

$$v = u + at$$

Substitute the known values:

$$0 = 150 + a \times 0.03$$

$$a = \frac{-150}{0.03} = -5000 \text{ m/s}^2$$

The negative sign indicates that the velocity of the bullet is decreasing, meaning the bullet is decelerating as it penetrates the block.

Using the third equation of motion:

$$v^2 = u^2 + 2as$$

Substitute the known values:

$$0 = (150)^2 + 2 \times (-5000) \times s$$

Solve for s :

$$0 = 22500 - 10000 s$$

$$10000 s = 22500$$

$$s = \frac{22500}{10000} = 2.25 \text{ m}$$

Hence, the distance of penetration of the bullet into the block is 2.25 m.

From Newton's second law of motion:



$$F = ma$$

Substitute the known values:

$$F = 0.01 \times 5000 = 50 \text{ N}$$

Q. 14. An object of mass 1 kg travelling in a straight line with a velocity of 10 m s^{-1} 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.

ANSWER:-

Given- Mass of the object, $m_1 = 1 \text{ kg}$, Velocity of the object before collision, $v_1 = 10 \text{ m/s}$, Mass of the stationary wooden block, $m_2 = 5 \text{ kg}$, Velocity of the wooden block before collision, $v_2 = 0 \text{ m/s}$

Need to find- total momentum

Calculating the total momentum before collision

Using the formula for momentum:

$$\text{Total momentum before collision} = m_1 v_1 + m_2 v_2$$

Substitute the given values:

$$= 1 \times 10 + 5 \times 0 = 10 \text{ kg}\cdot\text{m/s}$$

So, the total momentum before the collision is $10 \text{ kg}\cdot\text{m/s}$.

After the collision, the object and the wooden block stick together, forming a combined system.

- Total mass of the combined system = $m_1 + m_2$
- Let the velocity of the combined object be v .

Using the law of conservation of momentum

Total momentum before collision = Total momentum after collision

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2)v$$

Substitute the known values:

$$1 \times 10 + 5 \times 0 = (1 + 5)v$$

$$10 = 6v$$

Solve for v :

$$v = \frac{10}{6} = \frac{5}{3} = 1.67 \text{ m/s}$$

Q. 15. An object of mass 100 kg is accelerated uniformly from a velocity of 5 m s^{-1} to 8 m s^{-1} in 6 s. Calculate the initial and final momentum of the object. Also, find the magnitude of the force exerted on the object.

ANSWER:-

Given-Initial velocity of the object, $u = 5 \text{ m/s}$, Final velocity of the object, $v = 8 \text{ m/s}$, Mass of the object, $m = 100 \text{ kg}$, Time taken by the object to accelerate, $t = 6 \text{ s}$

Initial momentum is given by:

$$\text{Initial momentum} = m \times u$$

Substitute the values:

$$= 100 \times 5 = 500 \text{ kg}\cdot\text{m/s}$$

So, the initial momentum is $500 \text{ kg}\cdot\text{m/s}$.



Final momentum is given by:

$$\text{Final momentum} = m \times v$$

Substitute the values:

$$= 100 \times 8 = 800 \text{ kg}\cdot\text{m/s}$$

The formula for force exerted on the object is:

$$F = \frac{m(v - u)}{t}$$

Substitute the values:

$$F = \frac{100(8 - 5)}{6} = \frac{100 \times 3}{6} = \frac{300}{6} = 50\text{N}$$

Q. 16. Akhtar, Kiran and Rahul were riding in a motorcar that was moving with a high velocity on an expressway when an insect hit the windshield and got stuck on the windscreen. Akhtar and Kiran started pondering over the situation. Kiran suggested that the insect suffered a greater change in momentum as compared to the change in momentum of the motorcar (because the change in the velocity of the insect was much more than that of the motorcar). Akhtar said that since the motorcar was moving with a larger velocity, it exerted a larger force on the insect. And as a result, the insect died. Rahul while putting an entirely new explanation said that both the motorcar and the insect experienced the same force and a change in their momentum. Comment on these suggestions.

ANSWER:-

According to the law of conservation of momentum, the total momentum of the car and insect system before the collision is the same as after the collision. This means the total momentum doesn't change. When the insect hits the windscreen, it gets stuck, and its direction changes. This causes a big change in the insect's speed. On the other hand, the car keeps moving at almost the same speed. So, Kiran is right in saying that insects have a bigger change in momentum compared to the car. Since the car is moving fast, the insect gains a lot of momentum, while the car loses an equal amount. The momentum gained by the insect is equal to the momentum lost by the car.

Akhtar is also correct because the car is much heavier than the insect, so the car's momentum doesn't change much, but the insect's momentum changes a lot.

Rahul is mostly right about both the car and insect experiencing equal forces, as per Newton's third law. However, he made a mistake when he said the system's momentum changes. The total momentum of the system stays the same before and after the collision, so it doesn't change.

Q. 17. How much momentum will a dumbbell of mass 10 kg transfer to the floor if it falls from a height of 80 cm? Take its downward acceleration to be 10 m s⁻².

ANSWER:-

Mass of the dumbbell, $m = 10 \text{ kg}$

Distance covered by the dumbbell, $s = 80 \text{ cm} = 0.8 \text{ m}$

Acceleration in the downward direction, $a = 10 \text{ m/s}^2$

Initial velocity of the dumbbell, $u = 0$



Final velocity of the dumbbell (when it was about to hit the floor) = v

According to the third equation of motion:

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + 2(10)0.8$$

$$v = 4 \text{ m/s}$$

Hence, the momentum with which the dumbbell hits the floor is

$$= mv$$

$$= 10 \times 4 \text{ kg m s}^{-1}$$

$$= 40 \text{ kg m/s}$$

<https://t.me/veda9and10>

