Multiple Choice Questions

1. Which of the following statements is not correct for an object moving along a straight path in an accelerated motion?

(a) Its speed keeps changing

(b) Its velocity always changes

(c) It always goes away from the earth

(d) A force is always acting on it

Answer: (c) It always goes away from the earth

Explanation: In order to move away from the Earth, an object requires acceleration which should be more than the acceleration due to the gravity of Earth. Moving on a straight path is not sufficient for an object to escape the gravitation of the earth.

According to the third law of motion, action and reaction (a) always act on the same body (b) always act on different bodies in opposite directions (c) have the same magnitude and directions (d) act on either body at normal to each other.

2. According to the third law of motion, action, and reaction

(a) always act on the same body

(b) always act on different bodies in opposite directions

(c) have the same magnitude and directions

(d) act on either body at normal to each other

Answer: (b) always act on different bodies in opposite directions

Explanation: Newton's third law states that "For every action, there is an equal and opposite reaction". Hence answer is b)

3. A goalkeeper in a game of football pulls his hands backward after holding the ball shot at the goal. This enables the goalkeeper to

a. Exert a larger force on the ball

b. Reduce the force exerted by the ball on the hands

c. Increase the rate of change of momentum

d. Decrease the rate of change of momentum

Answer: The correct option is (b) **to** reduce the force exerted by the ball on the hands

Explanation: Pulling the hand backward gives enough time to reduce the momentum of the ball which thus helps in reducing the force exerted by the ball on the hands.

4. The inertia of an object tends to cause the object

a. To increase its speed b. To decrease its speed

c. To resist any change in its state of motion d. To decelerate due to friction

Answer: The correct option is (c), to resist any change in its state of motion.

Explanation: Inertia is understood as the property because of which an object resists any change in its state of motion.

5. A passenger in a moving train tosses a coin that falls behind him. It means that the motion of the train is

a. Accelerated b. Uniform c. Retarded d. Along circular tracks

Answer: The correct option is (a) accelerated

Explanation: If the motion of the train was uniform, the coin would have fallen in the passenger's hand. If the motion had been retarded, the coin would have fallen ahead of the passenger. So, the motion is accelerated because it falls behind him.

6. An object of mass 2 kg is sliding with a constant velocity of 4 m/s on a frictionless horizontal table. The force required to keep the object moving with the same velocity is

(a) 32 N (b) 0 N (c) 2 N (d) 8 N

Answer:(b) 0 N

Explanation: Here the friction is opposing the force hence no force is required to keep the object in uniform motion. Hence, the answer is 0 N.

7. Rocket works on the principle of conservation of

a. Mass b. Energy c. Momentum d. Velocity

Ans: The correct option is (c) momentum

Explanation- High velocity of hot gasses coming out from the rocket is balanced by the upward movement of the rocket. This gas has a large momentum and an equal momentum is acted to the rocket in the opposite direction due to which the rocket moves upward. Their conservation of momentum is working.

8. A water tanker filled up to 2/3 of its height is moving with a uniform speed. On sudden application of the brake, the water in the tank would

a. Move backward b. Move forward c. Be unaffected d. Rise upwards

Answer: The correct option is (b) move forward.

Explanation: By sudden application of the brake, the tanker would come to rest however, water would remain in motion hence it would move forward.

Short Answer Questions

Q9. There are three solids made up of aluminium, steel and wood, of the same shape and same volume. Which of them would have the highest inertia?

Answer: As the mass is a measure of inertia, the solid of the same shape and size having more mass than other solids will have the highest inertia. Out of aluminum, steel, and wood, the density of steel is maximum and hence the mass, therefore, a solid made up of steel would have the highest inertia.

Q10. Two balls of the same size but of different materials, rubber, and iron are kept on the smooth floor of a moving train. The brakes are applied suddenly to stop the train. Will the balls start rolling? If so, in which direction? Will they move at the same speed? Give reasons for your answer.

Answer: Yes, the balls will start rolling in the direction in which the train is moving. This is because, after applying the brakes, train comes to rest but the balls continue to move due to inertia. Since the masses of the balls are different and hence the inertial forces, the balls will move at different speeds. Iron ball being heavier than the rubber ball will move at a lower speed.

Q11. Two identical bullets are fired one by a light rifle and another by a heavy rifle with the same force. Which rifle will hurt the shoulder more and why?

Answer: According to the law of conservation of momentum; the momentum of the bullet forward will be equal to the momentum of the rifle backward. In the case of a light rifle; the velocity will be more than the velocity of a heavier rifle because of mass so the momentum (product of mass and velocity) for both shall not be equal. Due to this, the lighter rifle will hurt the shoulder more. In both cases, it has been called recoiled.

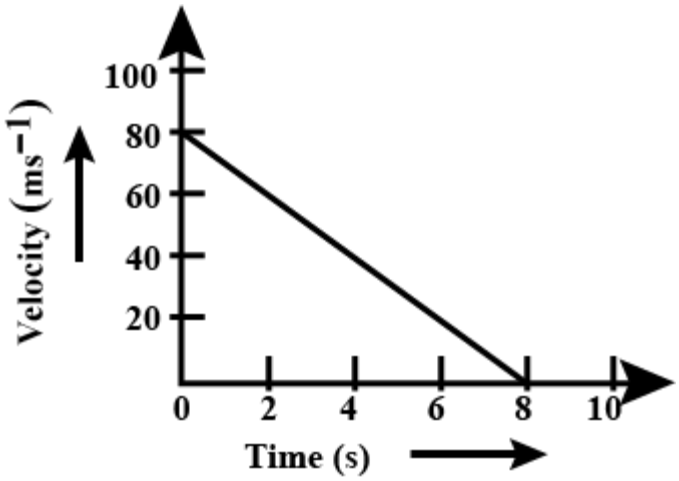
Q12. A horse continues to apply a force to move a cart at a constant speed. Explain why?

Answer: When a cart is moving on the road, it needs to encounter friction. To maintain a constant speed, some force needs to be applied continuously to overcome this friction. Therefore, the horse needs to apply a force continuously to move the cart at a constant speed.

Q13. Suppose a ball of mass m is thrown vertically upward with an initial speed v, its speed decreases continuously till it becomes zero. Thereafter, the ball begins to fall downward and attains the speed v again before striking the ground. It implies that the magnitude of the initial and final momentums of the ball are the same. Yet, it is not an example of conservation of momentum. Explain why?

Answer: The law of conservation of momentum applies to isolated systems. In this case, the change in velocity is due to the gravitational force of Earth.

Q14. Velocity versus time graph of a ball of mass 50g rolling on a concrete floor is shown above. Calculate the acceleration and the frictional force of the floor on the ball?



Answer: We know that Acceleration a = $\frac{v-u}{t}$ = = $\frac{0-80}{8-0}$ = - 10 ms^{-2}

Now, Force = ma

M = 50g = $\frac{50}{1000}$ kg

So, F = ma = $\frac{50}{1000}$ x 10 = 0.5N

frictional force opposes the motion, so it is taken as positive with a direction opposite to velocity.

Q15. A truck of mass M is moved under a force F. If the truck is then loaded with an object equal to the mass of the truck and the driving force is halved, then how does the acceleration change?

Answer:

F = ma

According to the question, a body of the same mass is loaded.

Total Mass = m + m = 2m

Force = $\frac{1}{2}$ F

F = ma

$\Rightarrow \frac{1}{2}$ F = 2ma

$\therefore$ a = $\frac{F}{4m}$

So, acceleration becomes 1/4 times

Q16. Two friends on roller skates are standing 5 m apart facing each other. One of them throws a ball of 2 kg towards the other, who catches it, how will this activity affect the position of the two? Explain your answer.

Answer: The separation between them will increase. Initially, the momentum of both of them is nil as they are at rest. To conserve momentum, one of them who throws the ball would move backward and the other one would experience a net force after catching it so he would move backward (in the direction of the force).

Q17. The water sprinkler used for grass lawns begins to rotate as soon as the water is supplied. Explain the principle on which it works.

Answer: The rotation of water sprinklers used for grass lawns can be explained on the basis of Newton's third law of motion. As soon as the water comes out of sprinkler, it exerts an equal and opposite force on the sprinkler and it starts rotating.

Long Answer Type Questions

Q18. Using the second law of motion, derive the relation between force and acceleration. A bullet of 10 g strikes a sandbag at a speed of 10^3 m/s and gets embedded after traveling 5 cm. Calculate

(i) the resistive force exerted by the sand on the bullet

(ii) the time taken by the bullet to come to rest.

Answer:

Rate of change of momentum = $\frac{change\ in\ momentum}{Time\ taken} = \frac{m(v-u)}{t}$ .....(i)

Using v = u + at

$\therefore\ a = \frac{v-u}{t}$ .....(ii)

From (i) and (ii), we get

Rate of change of momentum = ma

According to Newton's second law of motion

Force $\propto$ m $\propto$ a

Then F = K ma ; k is a constant

$\therefore F = ma$

Mass of bullet, m = $10g = \frac{10}{1000}$ = 0.01 kg

The initial speed of a bullet, u = 10^3 m/s

Final velocity v = 0

Distance traveled by bullet, s = 5 cm = $\frac{5}{100}$ = 0.05 meter

From the equation of motion:

$v^2 - u^2 = 2as$

⇨ $0^2 - (10^3)^2$ = 2 x 0.05 x a

⇨ $(10^3)^2$ = 0.1 a

Or a = $= \frac{(10^3)^2}{0.1} = -\ 10^7\ ms^{-2}$

Now,

F = ma = $\frac{10}{1000}$ x $-\ 10^7\ ms^{-2}$

Resistive Force exerted by the sand on the bullet = - (force exerted on the sand)

⇨ - ma = - 0.01 x (- 10^7) N = 10^5 N

(ii) Calculating the time taken by the bullet to come to rest

By Equation of motion

v = u + at

v = 0 ; u = 10^3 ; a = - 10^7

or 0 = 10^3 + (- 10^7) t

or t = $\frac{1\ x\ 10^3}{-10^7}$ S = 10^{-4} s

Q19. Derive the unit of force using the second law of motion. A force of 5 N produces an acceleration of 8 ms^{-2} on a mass m1 and an acceleration of 24 ms^{-2} on a mass m2. What acceleration would the same force provide if both the masses were tied together?

Answer: According to Newton's second law:

F = ma = (kg)(ms^{-2}) = $kgms^{-2}$

1 $kgms^{-2}$ = 1 N

It Is also called a practical unit of force

This absolute unit of force is called Newton. Its symbol is N.

F = 5 N , a_1 = 8 ms^{-2} , a_2 = 25 ms^{-2}

$\therefore m_1 = \frac{F}{a_1} = \frac{5}{8}$ Kg and $m_2 = \frac{F}{a_2} = \frac{5}{24}$ Kg

Now, total mass when both the masses are tied together,

M = m_1 + m_2 = $\left(\frac{5}{8} + \frac{5}{24}\right)$kg

= $\left(\frac{15+5}{24}\right)$kg = $\frac{20}{24}$ kg = $\frac{5}{6}$ kg

$\therefore$ Acceleration, $a = \frac{F}{m} = \frac{5}{5/6} = 6\ ms^{-2}$

Q20. What is momentum? Write its SI unit. Interpret force in terms of momentum. Represent the following graphically

(a) momentum versus velocity when mass is fixed.

(b) momentum versus mass when velocity is constant.

Answer:

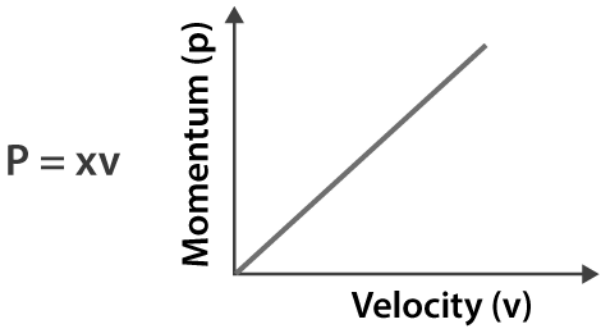
The quantity of motion of a moving body is called momentum. It is measured as a product of mass and velocity.

Momentum = mass × velocity

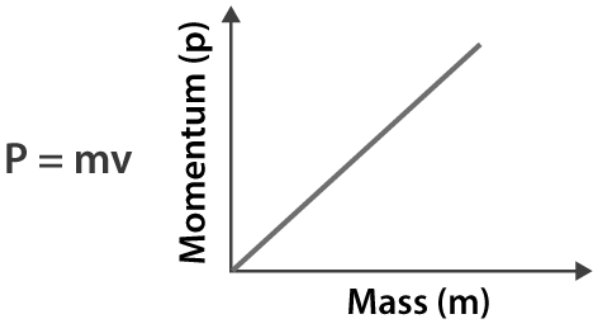
SI unit of momentum is kg m s^{-1}

Force = Rate of change in momentum

1)



2)



- The tendency of an object to resist change in its state of rest or motion is referred to as inertia.
- The mass of an object is the measure of its inertia and have SI unit as kilogram (kg)
- The motion of objects is always opposed by the force of friction.
- The SI unit of force is Newton (N) or kg m/s^2

One Newton is said to produce an acceleration of 1 m/s^2 on an object of mass 1 kg.

- The momentum of an object is defined as the product of mass of the object and its velocity.
- The momentum of an object has the same direction as the velocity of the object.
- Total momentum remains conserved when considering an isolated system, that is, where there is no external force applied.