CBSE Test Paper 03

Chapter 09 Forces and Laws of Motion

1. 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 stops because **(1)**

   a. Velocity is proportional to the force exerted on the ball.
   b. There is no unbalanced force on the ball, so the ball would want to come to rest.
   c. There is a force on the ball opposing the motion.
   d. The batsman did not hit the ball hard enough.

2. A gun recoiled to_____the momentum. **(1)**

   a. decrease
   b. conserve
   c. increase
   d. change

3. The people in the bus are pushed backwards, when the bus starts suddenly due to:- **(1)**

   a. Inertia due to Motion
   b. Inertia due to Rest
   c. Inertia due to Direction
   d. Inertia due to Speed

4. The action and reaction forces referred in the third law **(1)**

   a. Must act on the same object.
   b. May act on different objects.
   c. Need not be equal in magnitude but must have the same direction.
   d. May act on different objects.

5. According to the law of conservation of momentum **(1)**

   a. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
   b. None of the above

c. $m_1u_1 + m_1u_1 = m_2v_2 + m_2v_2$

d. $m_1u_1 - m_2u_2 = m_1v_1 - m_2v_2$

6. Define force of friction. **(1)**

7. Define 1 newton force. **(1)**

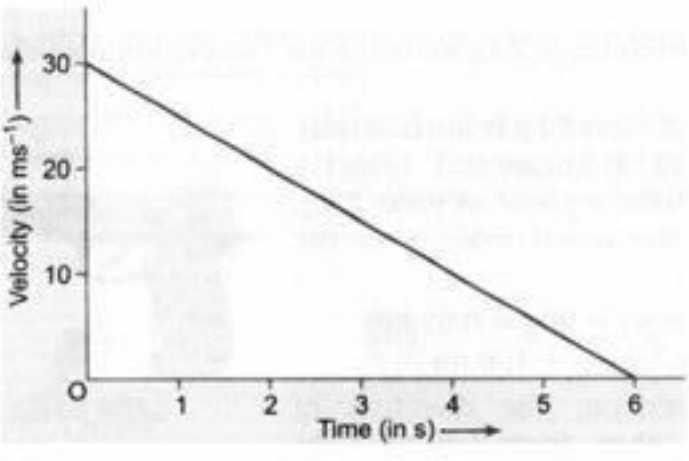
8. Plot a graph between force applied on a body and the acceleration produced in the given mass, assuming that the magnitude of force it constantly changing. **(1)**

9. What do you mean by an impact force? **(1)**

10. Why mass is sometimes called coefficient of linear inertia? **(1)**

11. What will be acceleration of a body of mass 5 kg, if a force of 200 N is applied on it? **(3)**

12. The velocity-time graph of a ball moving on the surface of a floor is shown in the figure. Find the force acting on the ball if the mass of the ball is 50 g. **(3)**



13. A scooter is moving with a velocity of 20 m/s when brakes are applied. The mass of the scooter and the rider is 180 Kg.The constant force applied by the brakes is 500 N.

a. How long should the brakes be applied to make the scooter come to a halt?

b. How far does the scooter travel before it comes to rest? **(3)**

14. Derive the mathematical relation of Newton's second law of motion. **(5)**

15. Describe Newton's first law of motion in detail, giving examples. **(5)**

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Answers

1. c. There is a force on the ball opposing the motion.

   Explanation: The ball slows down and comes to rest due to opposing forces of air resistance and frictional force on the ball opposing its motion.

2. b. conserve

   Explanation: Gun recoil results from conservation of total momentum of the bullet-gun system: the backward recoil gun momentum balances the forward bullet momentum to maintain zero total momentum.

3. b. Inertia due to Rest

   Explanation: Each body has an inertia of its own. It is an ability to resist any change in its state of motion.

   So when a person is sitting in bus, he is at rest. But the lower part of the body is attached to the bus which is in motion. Thus, the lower part of body attached to the bus seat starts moving but the upper part resists the motion and that is why we fall backwards.

4. d. May act on different objects.

   Explanation: Newton's Third Law of Motion states: 'To every action there is an equal and opposite reaction'. It must be remembered that action and reaction always act on different objects. Action of one object generates reaction in other.

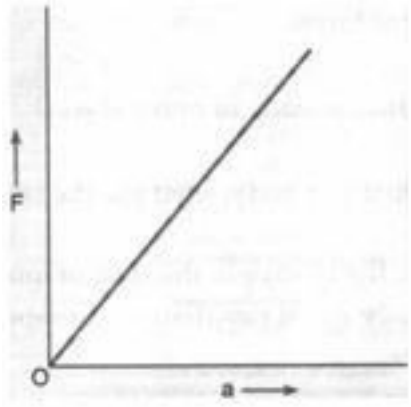
5. a. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

   Explanation: Law of conservation of momentum states that total momentum before collision is equal to total momentum after collision if no external force acts on it.

6. The force acting between any two surfaces in contact and tending to oppose motion is called the force of friction.These forces are mainly affected by the surface texture and amount of force impelling them together.

7. We define one newton as that force which when acting on a mass of 1 kg produces in it an acceleration of $1m/s^2$ in its own direction.

$1N = 1kgm/s^2$

8. 

9. The force produced by the impact of a fast moving object on another is called impact force.In mechanics,an impact is a high force or shock applied over a short time period when two or more bodies collide.
10. It is easier to pull a lighter body than a heavier body. Therefore, more the mass more will be the inertia. That is why mass is sometimes termed as coefficient of linear inertia. Inertia is directly proportional to the mass of the body.
11. Mass of the body (m) = 5 kg
    Force acting on the body (F) = 200 N
    ∴ Acceleration acting on the body = $a = \frac{F}{M} = \frac{200}{5} = 40ms^{-2}$
12. The velocity-time graph shows that velocity of the ball at t = 0 is 30 ms^{-1}
    Initial velocity of the ball, u = 30 ms^{-1}
    The velocity of the ball at t = 6 s is zero.
    Final velocity of the ball, v =0
    Time, t = 6s
    ∴ Acceleration of the ball,
    $a = \frac{v-u}{t} = \frac{0-30\,ms^{-1}}{6\,s}$
    = -5 ms^{-2}
    Negative sign shows that the ball is retarded or decelerated.
    Also, mass of ball, $M = 50\,g = \frac{50}{1000} = \frac{1}{20}\ kg$
    Therefore, Force acting on the ball, F = ma
    $= \left(\frac{1}{20}kg\right)(-5\,ms^{-2})$
    = - 0.25 kg ms^{-2}
    = 0.25 N [1 kg ms^{-2}= 1 N]
    Here -ve sign indicates that the force is retarding or stopping force.

13. Initial velocity,u=20 m/s

Final velocity,v=0

Mass,m = 180 Kg

Force,F = -500 N

a. $F = m \times a$

$\Rightarrow -500 = 180 \times a$

$\Rightarrow a = -2.78 ms^{-2}$

Now,

$v = u + at$

$\Rightarrow 0 = 20 - (2.78) \times t$

$\Rightarrow 2.78\,t = 20$

$\Rightarrow t = \frac{20}{2.78} = 7.2\,\text{sec.}$

Therefore,the brakes should be applied for min 7.2 sec to bring the scooter to a halt.

b. $S = ut + \frac{1}{2}at^2$

$\Rightarrow S = 20 \times 7.2 + \frac{1}{2} \times (-2.78) \times (7.2)^2$

$\Rightarrow S = 144 - 72.1 = 71.9\,m$

Therefore,the scooter will cover a distance of 71.9 m before it comes to rest.

14. Consider an object of mass 'm' moving along a straight line with an initial velocity 'u' (say). It is uniformly accelerated to velocity 'v' in time t by the application of a constant force 'F' for time 't'.

Then, initial momentum of the object = mu

$\therefore p_1$ =mu

Final momentum of the object = mv

$\therefore p_2$ =mv

$\therefore$ Change in momentum =$p_2 - p_1 = mv - mu$= $m(v - u)$

The rate of change in momentum $= \frac{m \times (v-u)}{t}$

According to Newton's second law of motion, we have

$F \propto \frac{M(v-u)}{t}$

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

Since,$a = \frac{v-u}{t}$

Therefore, $F = k \times m \times a$ ----------(i)

Here,

a= acceleration

k = a constant of proportionality.

When m = 1 kg, a = 1 ms^{-2} then F=1N

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

Let us substitute these values in equation (i),we get

$1N = k \times 1kg \times 1ms^{-2}$

$\therefore K = 1$

From equation (1), we have

F = ma

This represents the second law of motion.

Thus, the second law of motion gives a method to measure the force acting on an object as a product of its mass and acceleration.

15. According to Newton's first law of motion, a body at rest or in uniform motion will remain at rest or in uniform motion unless an unbalanced force acts upon it. Newton's first law defines inertia and is rightly called the law of inertia. This law consists of three parts:
    i. The first part says that a body at rest continues in its state of rest. For instance, a boy standing in a train falls backward when the train suddenly starts moving forward. This is because when the bus moves, the lower part of his body begins to move along with the train while the upper part of his body continues to remain at rest due to inertia.
    ii. The second part says that a body in uniform motion continues to move in straight line path with a uniform speed, e.g., when a moving train stops suddenly a person sitting in it falls forward. This is because as the train stops, the lower part of the person's body comes to rest along with the bus while upper part of his body continues to remain in motion due to inertia of motion and thus he falls forward.
    iii. Third part says that a body moving with a uniform speed in a straight line cannot change its direction of motion by itself. For example, when a bus takes a sharp turn, a person sitting in the bus gets force acting away from the centre of the curved path due to his tendency to move in the original direction.