CBSE Test Paper 02

Chapter 09 Forces and Laws of Motion

1. Weight of a body due to the Earth acts **(1)**
   a. vertically upwards
   b. towards the centre of earth
   c. in any direction
   d. horizontal
2. What is the S.I. unit of Momentum? **(1)**
   a. ms/Kg
   b. Kg ms
   c. Kg ms^{-1}
   d. Kg/ms
3. Dust particles come out of a hanging carpet when we strike it with a stick because- **(1)**

   A Carpet starts moving forward and backward due to inertia of motion

   B Dust particles remain at rest

   C Dust particles starts moving forward due to inertia of motion

   D Carpet remains at rest
   a. A and B is correct
   b. All of these
   c. B and C are correct
   d. A, B and C are correct
4. A plate, a ball and child all have the same mass. The one having more inertia is the **(1)**
   a. child
   b. plate
   c. All have equal inertia
   d. ball
5. Match the following with correct response.

Column A	Column B
(1) Unbalanced force	(A) Applying grease

(2) Unchanging tendency	(B) Change in state
(3) Method of reducing friction	(C) Force
(4) Rate of change of momentum	(D) Inertia

a. 1-C, 2-B, 3-D, 4-A

b. 1-B, 2-D, 3-A, 4-C

c. 1-D, 2-A, 3-C, 4-B

d. 1-A, 2-C, 3-B, 4-D

6. State Newton's second law of motion? **(1)**
7. Which principle is involved in the working of a jet plane? **(1)**
8. Which law of motion gives the measure of force? **(1)**
9. Does every force produce motion in every object? **(1)**
10. Suppose a ball of mass 'm' is thrown vertically upwards with an initial speed 'v', its speed decreases continuously till it becomes zero. Therefore, the ball begins to fall downward and attains the speed 'v' again before striking the ground. It implies that the magnitude of initial and final momenta of the ball are same. Yet, it is not an example of conservation of momentum. Explain why. **(1)**
11. How much momentum will a dumbbell of mass 10 kg transfer to the floor, if it falls from a height of 0.8 m? Take acceleration due to gravity as 10 ms^{-2}. **(3)**
12. With what speed must a ball be thrown vertically up in order to rise to a maximum height of 45 m? And for how long will it be in air? **(3)**
13. A motorcar of mass 1200 kg is moving along a straight line with a uniform velocity of 90 km/h. Its velocity is slowed down to 18 km h^{-1} in 4 s by an unbalanced external force. Calculate the acceleration and change in momentum. Also, calculate the magnitude of the force required. **(3)**
14. Derive the mathematical formula of conservation of momentum. **(5)**
15. Describe Newton's third law of motion. **(5)**

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Answers

1. b. towards the centre of earth

   Explanation: The weight of the body is the measure of force by which object is attracted towards the centre of earth. It always acts vertically downwards.

2. c. Kg ms^{-1}

   Explanation: The units of momentum are the product of the units of mass and velocity.

   Linear Momentum = Mass × Velocity

   S.I Unit of Momentum = S.I Unit of mass × S.I Unit of velocity

   S.I Unit of Momentum = kg × $m.s^{-1}$

   S.I Unit of Momentum = $kg.m.s^{-1}$

3. a. A and B is correct

   Explanation: Dust can be removed from a hanging carpet by shaking it or beating it with a stick. Initially, both the carpet and the dust are at rest. When the carpet is shaken or beaten with a stick, the carpets is set into motion while the dust remains in the state of rest due to the inertia of rest. Thus the dust falls down due to the pull of gravity.

4. c. All have equal inertia

   Explanation: Inertia is directly proportional to mass, hence all the above given objects will have equal inertia.

5. b. 1-B, 2-D, 3-A, 4-C

   Explanation:

   i. an unbalanced force cause change in the state of motion i.e. acceleration in a body.

   ii. inertia has an approach to remain conserved.

   iii. grease reduces the friction which may lead to wear and tear of machine parts.

iv. force can be defined as the rate of change of momentum.

6. According to Newton's second law of motion, the rate of change of momentum of a body is equal to the force acting on it and the change in momentum takes place in the same direction as the force applied.
7. Newton's third law of motion.
8. Newton's second law of motion gives the measure of force.
9. No. If, two equal and opposite forces acts on an object, they both cancel out each other. Hence, there will be no motion. The object will remain in the state of rest.
10. Law of conservation of momentum is applicable to isolated system (no external force is applied). In this case, the change in velocity is due to the gravitational force of earth.
11. Initial velocity (u) = 0, Final velocity (v) =?

    Height (S) = 0.8 m, Acceleration (g) = 10 ms^{-2}

    Using, $v^2 - u^2 = 2gS$ we have

    $v^2 - (0)^2 = 2 \times 10 \times 0.8$

    $v^2 = 16$ or $v = 4\ ms^{-1}$

    Therefore, Momentum of dumbbell = m $\times$ v

    = 10 kg $\times$ 4 ms^{-1} = 40 N.
12. Initial velocity, u=?

    Final velocity,v =0 (Body comes to rest)

    Acceleration due to gravity= - 9.8 m/s^2

    Distance,S = 45 m

    $v^2 = u^2 + 2gs$

    $\Rightarrow 0 = u^2 + 2(-10) \times 45$

    $\Rightarrow u^2 = 900$

    $\Rightarrow u = 30$

    Therefore, the ball must be thrown at a speed of 30ms^{-1}.

    Now, $v = v_0 + at$

    $\implies 0 = 30 + (-10)t$

    $\implies t = 3s$

    The ball takes 3s to go up.

    $\therefore$ The ball takes 3s to come down

$\therefore$ The total time of flight=6 sec.

$\therefore$ The ball will be in air for 6 sec.

13. i. Initial velocity of the car (u) = 90 kmh^{-1}

= 25 ms^{-1}

Final velocity of the car (v) = 18 kmh^{-1} = 5 ms^{-1}

Time (t) = 4s

Acceleration = (a) = ?

We know: v = u = at

5 = 25 + a $\times$ 4

$\therefore$ -a $\times$ 4 = 20

$\Rightarrow$ a = $\frac{-20}{4}$ = - 5ms^{-2}

ii. Change in momentum (p) = m (v - u)

= 1200 (5 - 25)

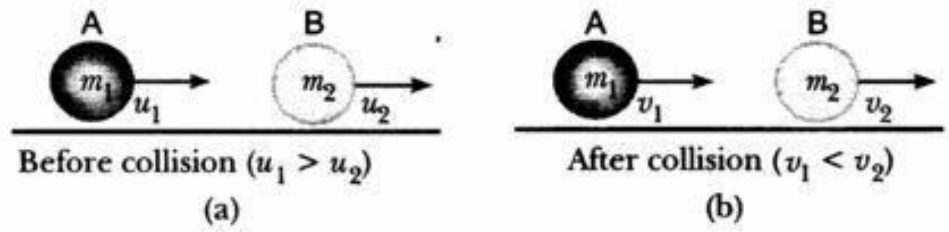
= 1200 $\times$ (-20)

= 2400 Ns

iii. Magnitude of force (F) = $\frac{m(v-u)}{t} = \frac{-24000}{4}$

= -6000 N

14. To explain the conservation of momentum, let us take the following example. Consider two balls A and B having masses m_1 and m_2 respectively. Let the initial velocity of ball A be u_1 and that of ball B be u_2 $(u_1 > u_2)$. Their collision takes place for a very short interval of time t and after that A and B start moving with velocities v_1 and $v_2 (v_1 < v_2)$ respectively as shown in Figure.



The momentum of ball A before and after the collision is m_1u_1 and m_1v_1 respectively. Similarly, the momentum of ball B before and after the collision is m_2u_2 and m_2v_2. If there are no external forces acting on the body, then the rate of change of momentum of ball A, during the collision will be

$= \frac{m_1(v_1-u_1)}{t}$

and, similarly the rate of change in momentum of ball B

$= \frac{m_2(v_2-u_2)}{t}$

Let F_{12} be the force exerted by ball A on B and F_{21} be the force exerted by ball B on A. Then, according to Newton's second law of motion

$F_{12} = \frac{m_1(v_1-u_1)}{t}; F_{21} = \frac{m_2(v_2-u_2)}{t}$

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

$F_{12} = -F_{21}$

$\Rightarrow \frac{m_1(v_1-u_1)}{t} = -\frac{m_2(v_2-u_2)}{t}$

$\Rightarrow m_1v_1 - m_1u_1 = -m_2v_2 + m_2u_2$

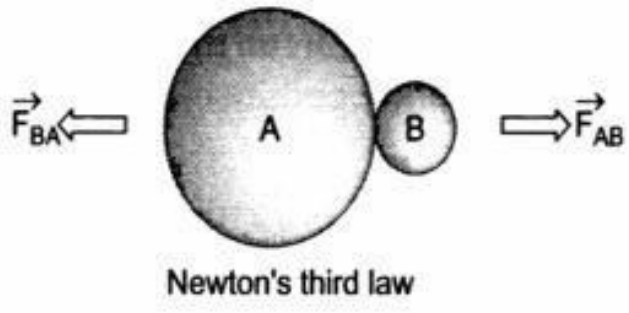
$\Rightarrow m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

i.e., Total momentum before collision =Total momentum after the collision

Thus, we find that in a collision between the two balls the total momentum before and after the collision remains unchanged or conserved provided no net force acts on the system. This result is the law of conservation of momentum.

15. According to Newton's third law of motion, 'To every action, there is an equal and opposite reaction; action and reaction forces act on different bodies.'

When an object, say A, exert a force (action) on another object, say B, then B also exerts a force (reaction) on the A. These two forces are always equal in magnitude but opposite in direction.



Newton's third law

As shown in the above figure, if F_{AB} be the force exerted by body A on B and F_{BA} is the force exerted by B on A, then according to Newton's third law of motion,

$\vec{F}_{AB} = -\vec{F}_{BA}$

or, Force on B by A = Force on A by B

or, Action = Reaction

This law clarifies that a single force can never exist and that the forces always exist in pairs. The two opposing forces are known as action and reaction. The forces of action and reaction always act on two different bodies.