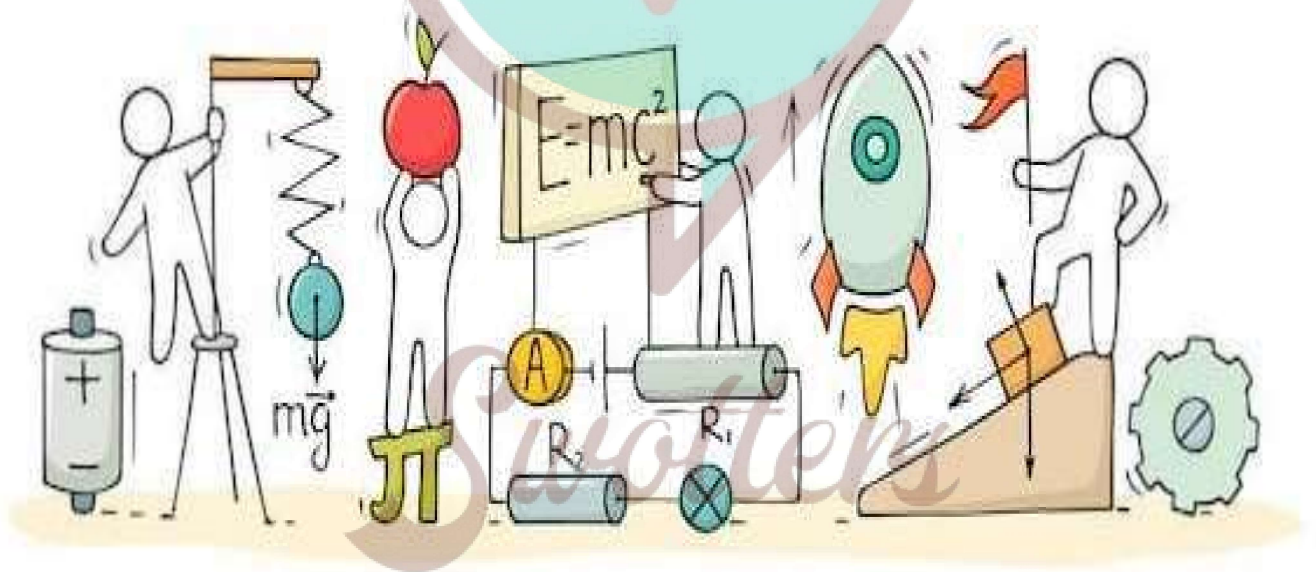


# PHYSICS

## Chapter 9: Force and Laws of Motion



## Important Questions

### ➤ 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
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 same magnitude and directions
  - (d) act on either body at normal to each other
3. A goalkeeper in a game of football pulls his hands backwards after holding the ball shot at the goal. This enables the goalkeeper to
  - (a) exert larger force on the ball
  - (b) reduce the force exerted by the balls on the hands
  - (c) increase the rate of change of momentum
  - (d) decrease the rate of change of momentum
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
5. A passenger in a moving train tosses a coin which falls behind him. It means that motion of the train is
  - (a) accelerated
  - (b) uniform
  - (c) retarded
  - (d) along circular tracks
6. An object of mass 2 kg is sliding with a constant velocity of 4 ms<sup>-1</sup> 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

7. Rocket works on the principle of conservation of

- (a) mass
- (b) energy
- (c) momentum
- (d) velocity

8. A water tanker filled up to  $\frac{2}{3}$  of its height is moving with a uniform speed. On a sudden application of brakes, the water in the tank would

- (a) move backward
- (b) move forward
- (c) be unaffected
- (d) rise upwards

9. If the mass of a body is doubled and its velocity becomes half, then the linear momentum of the body will

- (a) remain same
- (b) become double
- (c) become half
- (d) become four times.

10. When a number of forces acting simultaneously on a body bring about a change in its state of rest or of uniform motion in a straight line, then these forces acting on the body are said to be

- (a) balanced forces
- (b) equal forces
- (c) unbalanced forces
- (d) opposite forces

11. When a car at high speed makes a sharp turn, the driver in a car tends to get thrown to the side opposite to the turn. This is due to the

- (a) inertia of motion
- (b) inertia of time
- (c) inertia of rest

(d) inertia of direction

12. A man is standing on a boat in still water. If he walks towards the shore, then the boat will

- (a) move away from the shore
- (b) move towards the shore
- (c) remain stationary
- (d) none of these

13. Which of the following is an incorrect statement?

- (a) Mass is measure of inertia of a body.
- (b) Newton's first law of motion is the law of inertia.
- (c) Unbalanced force produces constant velocity.
- (d) Newton's third law talks about the direction of the force.

14. A ball is thrown vertically upward in a train moving with uniform velocity. The ball will

- (a) fall behind the thrower
- (b) fall ahead of the thrower
- (c) return back to the thrower
- (d) fall on the left of the thrower

15. Which of the following is not an application of conservation of linear momentum?

- (a) While firing a bullet, the gun must be held tight to the shoulder
- (b) When a man jumps from a boat to the shore
- (c) A rocket explodes on midway from the ground
- (d) A body suspended from the hook of a spring balanced in a lift which is accelerated downward

➤ **Very Short Question:**

1. Define force.
2. What is S.I. unit of force?
3. Define one Newton.
4. What is balanced force?
5. What is frictional force?
6. What is inertia?
7. State Newton's first law of motion.
8. State Newton's second law of motion.

9. What is momentum?
10. State Newton's III law of motion.

### ➤ Short Questions:

1. State the difference in balanced and unbalanced force.
2. What change will force bring in a body?
3. When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side. Explain why?
4. Explain why it is dangerous to jump out of a moving bus.
5. Why do fielders pull their hand gradually with the moving ball while holding a catch?
6. In a high jump athletic event, why are athletes made to fall either on a cushioned bed or on a sand bed?
7. How does a karate player breaks a slab of ice with a single blow?
8. What is law of conservation of momentum?

### ➤ Long Questions:

1. Explain Newton's second law of motion and with the-help of an example show how it is used in sports.
2. State all 3 Newton's law of motion. Explain inertia and momentum.
3. Define force. Give its unit and define it. What are different types of forces?

### ➤ Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
  - a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
  - b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
  - c. Assertion is true but Reason is false.
  - d. Both Assertion and Reason are false.

**Assertion:** If the net external force on the body is zero, then its acceleration is zero.

**Reason:** Acceleration does not depend on force.

2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

- Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
- Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
- Assertion is true but Reason is false.
- Both Assertion and Reason are false.

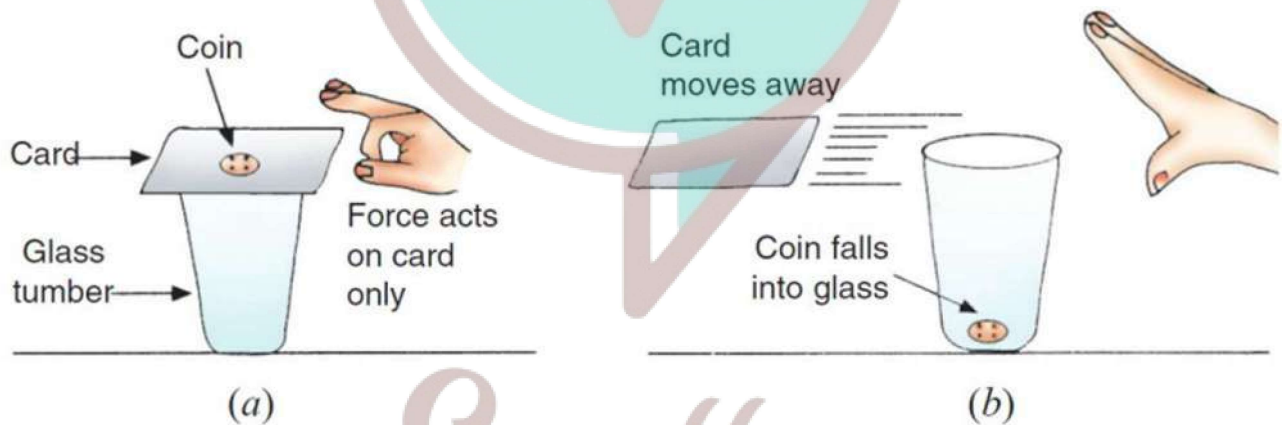
**Assertion:** A rocket works on the principle of conservation of linear momentum.

**Reason:** For two bodies system when there is a change in momentum of one body, the same change occurs in the momentum of the second body but in the opposite direction.

### ➤ Case Study Question:

- Read the following and answer any four questions from (i) to (v)

We take a glass tumbler and place a thick square card on its mouth as shown in Figure (a). A coin is then placed above this card in the middle. Let us flick the card hard with our fingers. On flicking, the card moves away but the coin drops into the glass tumbler [see Figure (b)].



- Give reason for the above observation.
  - The coin possesses inertia of rest, it resists the change and hence falls in the glass.
  - The coin possesses inertia of motion; it resists the change and hence falls in the glass.
  - The coin possesses inertia of rest, it accepts the change and hence falls in the glass.
  - The coin possesses inertia of rest, it accepts the change and hence falls in the glass.
- Name the law involved in this case.
  - Newton's second law of motion.
  - Newton's first law of motion.

(c) Newton's third law of motion.

(d) Law of conservation of energy

(iii) If the above coin is replaced by a heavy five rupee coin, what will be your observation. Give reason.

(a) Heavy coin will possess more inertia so it will not fall in tumbler.

(b) Heavy coin will possess less inertia so it will fall in tumbler.

(c) Heavy coin will possess more inertia so it will fall in tumbler.

(d) Heavy coin will possess less inertia so it will not fall in tumbler.

(iv) Name the law which provides the definition of force.

(a) Law of conservation of mass

(b) Newton's third law.

(c) Newton's first law

(d) Newton's second law.

(v) State Newton's first law of motion.

(a) Energy can neither be created nor be destroyed, it can be converted from one form to another, total amount of energy always remains constant.

(b) A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless it is acted upon by an external unbalanced force.

(c) For every action in nature there is an equal and opposite reaction.

(d) The acceleration in an object is directly related to the net force and inversely related to its mass.

2. Read the following and answer any four questions from (i) to (v)

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.



- (i) Whose suggestion is correct?
- (a) Akhtar's suggestion is incorrect as momentum is never conserved
  - (b) Kiran's suggestion is incorrect as momentum is always conserved
  - (c) Rahul's suggestion is incorrect as momentum is never conserved
  - (d) All of them have given correct suggestion.
- (ii) Define momentum.
- (a) Momentum is the product of mass and displacement.
  - (b) Momentum is the product of mass and distance.
  - (c) Momentum is the product of mass and velocity.
  - (d) Momentum is the product of mass and acceleration.
- (iii) What is the SI unit of momentum?
- (a) SI unit of momentum is kg
  - (b) SI unit of momentum is kg/s.
  - (c) SI unit of momentum is kg. m/s.
  - (d) SI unit of momentum is m/s.
- (iv) Find the momentum of a man of mass 75 kg when he walks with a velocity of 2 m/s.
- (a)  $P = 75 \text{ kgm/s}$
  - (b)  $P = 15 \text{ kgm}$
  - (c)  $P = 37.5 \text{ kgm/s}$
  - (d)  $P = 150 \text{ kgm/s}$
- (v) What is velocity?
- (a) Distance travelled in given time.
  - (b) Rate of change of momentum.
  - (c) Rate of displacement.
  - (d) Shortest distance travelled.



## ✓ Answer Key-

## ➤ Multiple Choice Answers:

1. (d) A force is always acting on it
2. (b) always act on different bodies in opposite directions
3. (d) decrease the rate of change of momentum
4. (c) to resist any change in its state of motion
5. (a) accelerated
6. (b) 0 N
7. (c) momentum
8. (b) move forward
9. (a) remain same
10. (d) opposite forces
11. (a) inertia of motion
12. (a) move away from the shore
13. (c) Unbalanced force produces constant velocity.
14. (c) return back to the thrower
15. (c) A rocket explodes on midway from the ground

## ➤ Very Short Answers:

1. Answer: It is a push or pull on an object that produces acceleration in the body on which it acts.
2. Answer: S.I. unit of force is Newton.
3. Answer: A force of one Newton produces an acceleration of  $1 \text{ m/s}^2$  on an object of mass 1 kg.  
 $1 \text{ N} = 1 \text{ kg m/s}^2$
4. Answer: When forces acting on a body from the opposite direction do not change the state of rest or of motion of an object, such forces are called balanced forces.
5. Answer: The force that always opposes the motion of object is called force of friction.
6. Answer: The natural tendency of an object to resist a change in their state of rest or of uniform motion is called inertia.
7. Answer: An object remains in a state of rest or of uniform motion in a straight line unless acted upon by an external unbalanced force.
8. Answer: The rate of change of momentum of an object is proportional to the applied

unbalanced force in the direction of the force.

9. Answer: The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. The S. I. unit is kg m/s. ( $p = mv$ )
10. Answer: To every action, there is an equal and opposite reaction and they act on two different bodies.

### ➤ Short Answers:

1. Answer:

<b>Balanced force</b>	<b>Unbalanced force</b>
1. Forces acting on a body from the opposite directions are same.	1. Forces acting on a body from two opposite directions are not same.
2. It does not change the state of rest or of motion of an object.	2. It do change the state of rest or of motion of an object.

2. Answer: Force can bring following changes in the body:
- It can change the speed of a body.
  - It can change the direction of motion of a body,
  - It can change the shape of the body.
3. Answer: It is due to law of inertia. When we are sitting in car moving in straight line, we tend to continue in our straight-line motion. But when an unbalanced force is applied by the engine to change the direction of motion of the motorcar. We slip to one side of the seat due to the inertia of our body.
4. Answer: While moving in a bus our body is in motion. On jumping out of a moving bus our feet touches the ground and come to rest. While the upper part of our body stays in motion and moves forward due to inertia of motion and hence we can fall in forward direction.
- Hence, to avoid this we need to run forward in the direction of bus.
5. Answer: While catching a fast moving cricket ball, a fielder on the ground gradually pulls his hands backwards with the moving ball. This is done so that the fielder increases the time during which the high velocity of the moving ball decreases to zero. Thus, the acceleration of the ball is decreased and therefore the impact of catching the fast moving ball is reduced.
6. Answer: In a high jump athletic event, athletes are made to fall either on a cushioned bed or on a sand bed so as to increase the time of the athlete's fall to stop after making the jump. This decreases the rate of change of momentum and hence the force.
7. Answer: A karate player applied the blow with large velocity in a very short interval of time on the ice slab which therefore exerts large amount of force on it and suddenly breaks the ice slab.

8. Answer: Momentum of two bodies before collision is equal to the momentum after collision.

In an isolated system, the total momentum remain conserved.

### ➤ Long Answers:

1. Answer: Newton's second law of motion: The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.

Let us assume:

Object of mass  $m$ , is moving along a straight line with an initial velocity 'u', It is uniformly accelerated to velocity  $v$  in time 't' by the application of force,

**$F$  throughout the time 't'.**

**Initial momentum of the object =  $p_1 = mu$**

**Final momentum of the object =  $p_2 = mv$**

**The change in momentum  $\propto p_2 - p_1$**   
 $\propto mv - mu$   
 $= m(v - u)$

**The rate of change of momentum  $\propto \frac{m(v - u)}{t}$**

**$\therefore$  Applied force  $F \propto \frac{m(v - u)}{t}$**

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

**$\therefore F = kma \quad \therefore a = \frac{v - u}{t}$**

**$k = \text{constant of proportionality}$**

**$F = \text{kg m/s}^2 = \text{Newton}$**

**Use of second law of motion in sports:**

In cricket field, the fielder gradually pulls his hands backward while catching a ball. The fielder catches the ball and gives swing to his hand to increase the time during which the high velocity of the moving ball decreases to zero.

The acceleration of the ball is decreased and therefore the impact of catching the fast moving ball is reduced.

If not done so, then the fast moving ball will exert large force and may hurt the fielder.

2. Answer: Newton's I law of motion: An object remains in a state of rest or of uniform

motion in a straight line unless acted upon by an external unbalanced force.

Newton's II law of motion: The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the-force.

Newton's III law of motion: To every action, there is an equal and opposite reaction and they act on two different bodies.

Inertia: The natural tendency of an object to resist a change in their state of rest or of uniform motion is called inertia.

Momentum: The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. Its S.I. unit is kgm/s.  $p = m \times v$

3. Answer: Force: It is a push or pull on an object that produces acceleration in the body on which it acts.

A force can do 3 things on a body

- (a) It can change the speed of a body.
- (b) It can change the direction of motion of a body.
- (c) It can change the shape of the body.

The S.I. unit of force is Newton.

Newton: A force of one Newton produces an acceleration of  $1 \text{ m/s}^2$  on an object of mass  $1 \text{ kg}$ .

$$1\text{N} = 1\text{kg m/s}^2$$

Types of forces:

- **Balanced force:** When the forces acting on a body from the opposite direction do not change the state of rest or of motion of an object, such forces are called balanced forces.
- **Unbalanced force:** When two opposite forces acting on a body move a body in the direction of the greater force or change the state of rest, such forces are called as unbalanced force.
- **Frictional force:** The force that always opposes the motion of object is called force of friction.

### ➤ Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

### ➤ Case Study Answer:

1. Answer:

- (i) (a) The coin possesses inertia of rest; it resists the change and hence falls in the glass.
- (ii) (b) Newton's first law of motion.
- (iii) (c) Heavy coin will possess more inertia so it will fall in tumbler.
- (iv) (c) Newton's first law
- (v) (b) A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless it is acted upon by an external unbalanced force.

**2. Answer:**

- (i) (b) Kiran's suggestion is incorrect as momentum is always conserved
- (ii) (c) Momentum is the product of mass and velocity.
- (iii) (c) SI unit of momentum is kg. m/s.
- (iv) (d)  $P = 150 \text{ kgm/s}$

**Solution:**

$$\begin{aligned}\text{Momentum, } P &= m \times v \\ &= 75 \times 2 \\ &= 150 \text{ kg.m/s}\end{aligned}$$

- (v) (c) Rate of displacement



Swotters