

## CHAPTER

# 08

# *Biomechanics and Sports*

## Newton's Laws of Motion

Issac Newton's laws of motion form the basic principles that are used in sports movements. A method of training that departs from these laws does not make sense mechanically.

These laws are divided into three parts, which are described as follows

### Newton's First Law of Motion

It is also known as Law of Inertia. This law states that "a body at rest will remain at rest and a body in motion will remain in motion at the same speed and in the same direction unless any external force is applied on it to change that state."

Newton's first law explains two fundamental concepts linked with motion and force

- It tells us that a stationary body will remain at rest until an external force is applied.  
For example, a golf ball will remain still unless a force, applied by the golf club, makes it move.
- It tells us that a moving body will continue to move with constant velocity unless acted upon by an external force.  
For example, golf ball will continue to move at a constant velocity unless a force acts on it to slow it down or change its direction.

### Application in Sports

Newton's first law of motion is applicable in sports, like Equestrian. In this

## CHAPTER CHECKLIST

- Newton's Laws of Motion
  - Equilibrium
  - Friction and Sports
  - Projectile in Sports
-

When the horse suddenly stops, the lower part of both the rider and the horse comes to rest but the rider's upper part remains in motion. Hence, he bends forward to avoid falling from the horse.

Some of the other applications in sports are given below

- **Softball** The ball is hit into the air. Eventually, gravity will act on the ball, pulling it down to the ground. Then, it will roll until friction between the ball and the grass stops it.
- **Soccer** When a soccer ball is kicked into the air, gravity will pull it back to the ground. Then, it will continue to roll until friction between the ball and the grass slows it down.
- **Dance** When a dancer leaps, he only stays in the air for a short period of time because air resistance and gravity work against him.
- **Basketball** When a basketball is shot, it takes a parabolic path due to gravity acting on it. Then it slows down due to air resistance and fluid friction.



**Basketball**

## Newton's Second Law of Motion

This law states that the "acceleration produced in an object due to extent force is directly proportional to the force producing it and inversely proportional to its mass."

When two unequal forces are applied to objects of equal mass, then the object to which greater force is applied, will move faster.

If equal force is applied to objects having different masses, the object having lighter mass will travel at a faster speed.

For example, a goal shooter who has received the ball at a strong position close to the goal, will only need

of force in the direction of the goal as the ball will need a greater change in momentum towards to its goal.

## Application in Sports

Newton's second law of motion can be applied in the sports like

- **Baseball** If a baseball player hits a ball with double the force, the rate at which the ball will accelerate (speed up) will be doubled.
- **Football** Football players can slow down, stop or reverse the direction of other players depending upon how much force they can generate and in which direction.
- **Sprints** In sprints (race) events, runners, running at top speed, pull themselves backward and slowly decrease their speed as sudden stop can lead to fall.



**Sprints**

## Newton's Third Law of Motion

This law states that "for every action, there is always an equal and opposite reaction." This law describes what happens to a body when it exerts a force on another body.

It is usual to call one of the forces involved *viz.* action force and the other as reaction force.

There are no strict rules that govern which force is in action, but for the purpose of sports mechanics, it is presumed that the athlete exerts the action force.

## Application in Sports

Newton's third law of motion is applicable in the sports mentioned below

- **High Jump** An athlete can jump higher off a solid

- **Sprints** When a sprinter (racer) pushes against the block, the block push back with the same force. The force through which block push, helps the sprinter to move forward with full energy.
- **Swimming** In swimming, we can relate this concept to the standard hand/arm stroke when the hand travels downward in the water and then backwards to propel the swimmer forward.

In creating an equal and opposite reaction, the swimmer is kept afloat and propelled forward.



Swimming

## Equilibrium

Equilibrium can be defined as a state of balance among forces acting within or upon a body.

In other words, it is a state in which all influences, forces are cancelled or counterbalanced by each other *i.e.* the sum of all opposite forces acting on it is zero. Thus, it is a scientific term describing balance and stability.

In the human body, a state of equilibrium occurs when its centre of gravity lies over the base and the gravity line falls within the base of the body.

The greater the body surface in contact with the ground, the larger is the base of support. Hence, the posture of sitting is more stable, easier and more comfortable than the posture of standing.

There are two types of equilibrium

### 1. Dynamic Equilibrium

It is a state of balance of all applied forces acting on a moving body.

In simple words, when the moving body is stable and balanced such that it results in movement with unchanging speed and direction, then the body is

### 2. Static Equilibrium

It is a state of balance that occurs when the body is at rest or in a motionless position, *i.e.* when the centre of gravity is in a static position.

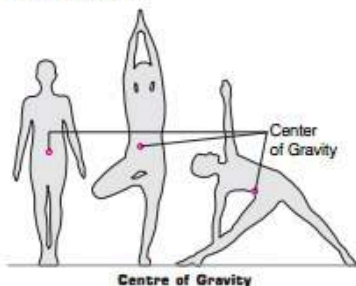
For instance, standing on one leg, sitting on a chair, etc.

## Centre of Gravity

The balance and stability of an individual depends upon the centre of gravity. Centre of gravity of a body is an imaginary point around which the body of the object is balanced. In human being, the centre of gravity can simply be considered as the centre of weight of the body.

The weight of the body is just the sum of individual weights of its components like arms, legs etc. The centre of gravity has the property of continuously changing during movement. The centre of gravity depends on the shape and size of the body. If a body has more mass distributed in its upper part, the centre of gravity will be towards the top of the body.

Centre of gravity always changes its direction according to movement. The knowledge of centre of gravity is very important in sports and for sportspersons. It is necessary for better skill in sports.



Centre of Gravity

For instance, a basketball player, while jumping up to score a basket, swings both arms upward and forward to raise his centre of gravity and thus reach the maximum height. But once in the air, the player drops one arm to his side and tries to reach the maximum with the other arm to score a basket. This reduces his centre of gravity, so that he does not become unstable.

### Applications of Centre of Gravity in Sports

The knowledge of equilibrium and centre of gravity are

Proper application of the concepts in sports can improve performance. This can be done by following the methods given below

- A sportsperson can become more stable by lowering his/her centre of gravity.
- To maintain balance during a performance, the sports person must ensure that the centre of gravity remains over and nearer his support base. When the center of gravity is beyond the base, balance is lost.
- For rapid movement of his body from a position of readiness, the sportsperson should position his body so that his centre of gravity has to move the minimum distance to clear the support base. This is particularly applicable during the start of sprint races.
- Shifting the centre of gravity towards an approaching force increases the sportsperson's ability to maintain balance.

When lifting or carrying an object, shift the body weight in order to maintain balance.

## Friction and Sports

The force acting along two surfaces in contact which opposes the motion of one body over the other is called the force of friction. It is very important in sports. The larger the area of contact between the surfaces, the greater is the force of friction.

For example, when a football is hit, then it travels very fast in a particular direction, but after a few seconds, its movement decreases and finally it stops due to frictional force of ground.

When both the surfaces are smooth, the force of friction reduces to almost zero.

### Types of Friction

Types of friction are as follows

#### 1. Static Friction

The opposing force that comes into play when one body tends to move over the another surface, but the actual motion has yet not started, is called static friction.

For example, when you hit a tennis ball, the friction applied is static.

#### 2. Dynamic Friction

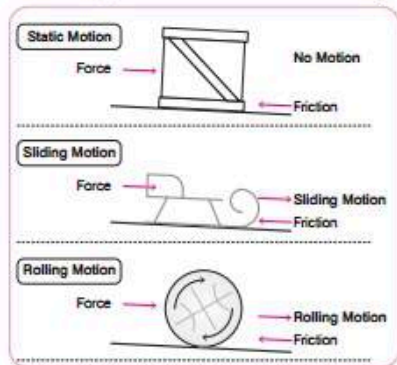
It is the friction between two surfaces that are in relative

It is further divided into two parts

- **Sliding Friction** The term sliding friction refers to the resistance created by two objects sliding against each other. This is also called kinetic friction.

Sliding friction is intended to stop an object from moving. It takes place due to interlocking between microscopic surfaces.

For example, when an ice-skater is skating.



Type of Frictions

- **Rolling Friction** The force resisting the motion of a rolling body on a surface is known as rolling friction or rolling resistance. Rolling of ball or wheel on the ground is an example of rolling friction.

It is considerably weaker than sliding friction. Rolling friction takes place due to deformation of surfaces.

Another example is of a basketball, which when rolled on the court will eventually come to a halt because of rolling friction.

#### 3. Fluid Friction

It is a friction that occurs when objects move across or through a fluid.

For example, in swimming, fluid friction is witnessed as when a person is going through water and the water pulls on it to slow it down or grabs onto it to try and have a bigger force. So, there is internal friction, which is the result of the interactions between molecules and fluid

## Friction in Sports

It is important to understand the role of friction in sports to bring efficiency in playing that sport. Friction is also called a necessary evil. It may hamper performance in certain sports like cycling, roller skating, skiing etc.

If the friction is more, then the cyclist will have to put more effort to cycle. If there is less friction between the road and tyres, then it will become too slippery and the cyclist may fall. Athletes, footballers, hockey players and sprinters, prefer to wear studs (shoes with spikes) to have proper friction that helps them in running fast without slipping.

Likewise, sportsperson performing various sports like weightlifting and gymnastics like to pad their palms with lime powder for better grip of the horizontal bars.

Badminton, squash players who need to hold the racket firmly also use gripping tapes to manage friction.

## Methods of Reducing Friction

Common methods of reducing friction are as follows

- **Polishing** By polishing the surfaces in contact, they become smooth and the force of friction reduces. Many equipments like the discus are painted to reduce friction.
- **Lubrication** The lubrication of surfaces makes them slippery and this reduces the force of friction.
- **Material Used** The force of friction largely depends on the type of material used. The friction between rubber and concrete is less than the friction between iron and concrete. That is why, tyres are made from rubber.
- **Streamlining** Friction due to air is reduced by streamlining the shape of the body. The aeroplanes are made with a sharp front to reduce friction.
- **Use of Ball Bearings** Use of ball bearings in the bicycle rim replace sliding friction, with rolling friction thus, providing better motion to the wheel.
- **Shoes and Spikes** In athletics, the shoes are designed to increase friction so that better speed can be generated. The spikes have small nails to increase the friction.
- **Use of Special Equipments** The cyclists use pointed helmets, silk body fitted costume and bend their bodies while cycling to reduce air friction. Swimmers use goggles, cap and full body swimsuit to reduce the force of friction caused by water.

## Projectile in Sports

A projectile is anything which is thrown or jumped into the air. Once it has left the ground it will follow a flight path called a parabola until it once more comes back down to earth. This applies to balls, javelins, discus, long jumpers, high jumpers, and horses show jumping.

An object must be dropped from a height, thrown vertically upwards or thrown at an angle to be considered a projectile. The path followed by a projectile is known as a trajectory. If gravity were not present, a projectile would travel in a constant straight line. However, the presence of gravity forces projectiles to travel in a parabolic trajectory, thus gravity accelerates objects downwards.

## Factors affecting the trajectory

Factors affecting the trajectory are as follows

- Angle of projection
- Projection velocity
- Relative height of projection

In order to analyse projectile motion, it is divided into two components, horizontal motion and vertical motion. Perpendicular components of motion are independent of each other i.e. the horizontal and vertical motions of a projectile are independent. Horizontal motion of an object has no external forces acting upon it (with the exception of air resistance but this is generally not accounted for).

Due to this absence of horizontal forces, a projectile remains in motion with a constant horizontal velocity, covering equal distances over equal periods in time. Thus no horizontal acceleration is occurring. The degree of vertical velocity however, is reduced by the effect of gravity.

Force of gravity acts on the initial vertical velocity of the javelin, reducing the velocity until it equals zero. A vertical velocity of zero represents the apex of the trajectory, meaning that the projectile has reached its max height. During the downward flight of the projectile, vertical velocity increases due to the effect of gravity.

# CHAPTER PRACTICE

## OBJECTIVE TYPE QUESTIONS

### Multiple Choice Questions (MCQs)

1 Friction always acts ..... the motion of an object. CBSE 2020

- (a) in the same direction as
- (b) perpendicular to
- (c) opposite to
- (d) at a 45 degree angle to

Ans (c) opposite to

2 Understanding of proper sports and exercise movements will allow the participant to be more ..... for long-term development.

- (a) Efficient
- (b) Technically sound
- (c) Prone to good habits
- (d) All of the above

Ans (d) All of the above

3 ..... refers to the resistance created by two objects sliding against each other.

- (a) Rolling Friction
- (b) Sliding Friction
- (c) Static Friction
- (d) Fluid Friction

Ans (b) Sliding Friction

4 ..... is the friction between two surfaces that are in relative motion with respect to each other.

- (a) Static friction
- (b) Rolling friction
- (c) Dynamic friction
- (d) Fluid friction

Ans (c) Dynamic friction

5 "Acceleration of an object is directly proportional to the force exerted upon it." It is related with CBSE 2021 Term I

- (a) Newton's 1st Law of Motion
- (b) Newton's 2nd Law of Motion
- (c) Newton's 3rd Law of Motion
- (d) Both (a) and (b)

Ans (b) Newton's 2nd Law of Motion

6 Newton's which law states that every object will remain at rest or in motion until any external force is applied? CBSE 2021 Term I

- (a) Newton's 1st Law of motion
- (b) Newton's 2nd Law of motion

7 Rishi who was studying in class XII is a science stream student. During his Physical Education class, he got confused how Newton's Laws of Motion are useful in sports and how they can be applied in sports. But his teacher explained these laws with help of examples from sports which proved to be very helpful for him. Swimming is the best example of which law of motion? CBSE SQP 2021 Term I

- (a) Law of Inertia
- (b) Law of Acceleration
- (c) Law of Reaction
- (d) Both (a) and (c)

Ans (c) Law of Reaction

8 Assertion (A) "A change in the acceleration of an object is directly proportional to the force producing it and inversely proportional to its mass." CBSE SQP 2021 Term I

Reason (R) Lighter mass will travel at a faster speed.

Codes

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true, but R is not the correct explanation of A
- (c) A is true, but R is false
- (d) A is false, but R is true

Ans (b) Both A and R are true and R is the correct explanation of A

9 Assertion (A) Equilibrium is a state of balance among forces acting within or upon a body.

Reason (R) It is a state in which all influences, forces are cancelled or counterbalanced by each other.

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true, but R is not the correct explanation of A
- (c) A is true, but R is false
- (d) A is false, but R is true

Ans (b) Both A and R are true, but R is not the correct explanation of A

Fill in the Blanks

**11** The force acting along two surfaces in contact which opposes the motion of one body over the other is called \_\_\_\_\_.

**Ans** Force of friction

**12** Friction due to air is reduced by \_\_\_\_\_ the shape of the body.

**Ans** streamlining

### State True or False

**13** A basketball which when rolled on the court will eventually come to a halt because of rolling friction.

**Ans** True

**14** When we hit a tennis ball, the friction applied is dynamic.

**Ans** False. When we hit a tennis ball, the friction applied is static.

### Match the Following

**15**

List I	List II
A Polishing	(i) It makes the surface slippery and this reduces the force of friction.
B Lubrication	(ii) It makes the surface smooth and reduce the force of friction.
C Shoes and Spikes	(iii) It replaces sliding friction with rolling friction.
D Use of Ball Bearings	(iv) They are designed to increase friction so that better speed can be generated.

#### Codes

- |           |       |       |       |
|-----------|-------|-------|-------|
| A         | B     | C     | D     |
| (a) (ii)  | (i)   | (iv)  | (iii) |
| (b) (i)   | (ii)  | (iii) | (iv)  |
| (c) (iii) | (iv)  | (i)   | (ii)  |
| (d) (iv)  | (iii) | (ii)  | (i)   |

**Ans** (a) (ii) (i) (iv) (iii)

## VERY SHORT ANSWER TYPE QUESTIONS

**16** What is the First Law of Newton?

**Ans** This law states that a body at rest will remain at

**17** What do you mean by static equilibrium?

**Ans** When the forces that act upon an object are equally balanced and its centre of gravity is in a static position, the object is considered to be in a state of static equilibrium.

**18** What do you understand by the term 'centre of gravity'?

**Ans** The centre of gravity of a body or object is an imaginary point around which the body of the object is balanced.

**19** What is friction?

**Ans** The force acting along two surfaces in contact which opposes the motion of one body over the other is called the force of friction.

**20** Explain, what is 'dynamic friction'.

All India 2016

**Ans** Dynamic friction is the opposing force that comes into play when one body is actually moving over the surface of another body. Dynamic friction may be of two types, i.e. sliding friction and rolling friction.

**21** What do you mean by rolling friction?

Delhi 2014

**Ans** Rolling friction is the resistance to motion experienced by a body when it rolls upon another. For example, a cricket ball rolling on the grass stops after sometime due to rolling friction.

**22** Explain the term sliding friction.

**Ans** The term sliding friction refers to the resistance created by two objects sliding against each other. This can also be called as kinetic friction.

**23** Enlist the methods of reducing friction.

**Ans** Methods of reducing friction are  
(i) Polishing (ii) Lubrication  
(iii) Use of ball bearings (iv) Streamlining

## SHORT ANSWER TYPE QUESTIONS

**24** Write a short note on equilibrium.

**Ans** Equilibrium can be defined as a state of balance among forces acting within or upon a body.

In other words, it is a state in which all

Equilibrium, thus, can be called as a scientific term for balance and stability.

The equilibrium of a human body is directly related to the body surface. If the body surface is greater, there will be greater stability and balance. In simple words, sitting posture is easier and comfortable due to greater body surface as compared to standing posture.

There are two types of equilibrium

- (i) **Dynamic Equilibrium** It is a state of balance of all applied forces acting on a moving body. In other words, the body in motion is stable such that it has unchanging speed and direction.
- (ii) **Static Equilibrium** It is the state of balance that occurs when the body is at rest or a motionless position.

**25** "Friction is a necessary evil." Justify your answer with suitable examples from sport.

**Ans** Friction is usually called a necessary evil. It means that it is essential in games and sports. Without friction, we cannot give a better performance in the field of sports. Examples are spikes used by athletes for running and studs used in football as boots of the players. However, friction has disadvantages also. In cycling, there should not be more friction between road and the tyres of the cycle.

**26** What is projectile? State in brief.

**Ans** A projectile is anything which is thrown or jumped into the air. Once it has left the ground it will follow a flight path called a parabola until it once more comes back down to earth. This applies to balls, javelins, discus, long jumpers, high jumpers, and horses show jumping. An object must be dropped from a height, thrown vertically upwards or thrown at an angle to be considered a projectile. The path followed by a projectile is known as a trajectory. If gravity were not present, a projectile would travel in a constant straight line. However, the presence of gravity forces projectiles to travel in a parabolic trajectory, thus gravity accelerates objects downwards.

**27** In Equestrian sport, when the horse comes to rest, then the rider bends forward to avoid falling. Based on this, answer the

- (a) First
  - (b) Third
  - (c) Second
  - (d) None of these
- (ii) What does the second law of motion state?
- (a) Body at rest will remain at rest
  - (b) For every action, there is opposite reaction
  - (c) Less friction is needed for better performance
  - (d) Acceleration depends upon force applied and mass of an object
- (iii) A basketball taking a parabolic path is an example of
- (a) third law of motion
  - (b) sliding friction
  - (c) first law of motion
  - (d) flexion

**Ans.** (i) (a) First  
(ii) (d) Acceleration depends upon force applied and mass of an object  
(iii) (c) first law of motion

**28** The teachers as well as coaches always make their best efforts to improve the performance of their students in various competitive games and sports. They can help to improve the performance of students if they have adequate knowledge of biomechanics.



- (i) The more force one exerts on the downward bounce, the higher the ball bounces into the air. Which law is this statement being referred to?
- (a) Newton's 1st law
  - (b) Newton's 2nd law
  - (c) Newton's 3rd law
  - (d) Law of gravitation
- (ii) Among the above given pictures, Newton's 3rd law is depicted in
- (a) First
  - (b) Second
  - (c) Both (a) and (b)
  - (d) None of the above
- (iii) The acceleration of an object depends



- Ans** (i) (c) Newton's 3rd law  
(ii) (c) Both (a) and (b) (iii) (b) Mass

**29** During the physical education class Newton's Laws of motion were discussed and their practical application in sports events was explained to students. These laws are most relevant in sports as most of the actions in sports are related to these laws. On the basis of this information answer the following questions.

- (i) Newton's First Law of Motion is also known as  
(a) Law of inertia (b) Law of momentum  
(c) Law of reaction  
(d) Law of acceleration
- (ii) What is the relationship between mass and force?  
(a) Directly proportional  
(b) No relationship  
(c) Inversely proportional  
(d) Both (a) and (c)
- (iii) Newton's second law is also known as  
(a) The law of reaction  
(b) The law of inertia  
(c) The law of acceleration  
(d) None of the above

- Ans** (i) (a) Law of inertia  
(ii) (a) Directly proportional  
(iii) (c) The law of acceleration

## LONG ANSWER TYPE QUESTIONS

**30** Explain Newton's laws of motion and their application in sports. **CBSE 2020**

**Ans** Newton's laws of motion have multiple application in sports. Each law and its application in sports is discussed below

- (i) **Newton's First Law** It states that a body at rest will remain at rest and a body in motion will remain in motion at the same speed and in the same direction till any external force is applied on it to change that state.

This law is also known as 'Law of inertia'. This law has an application in many games such as soccer, in which when a soccer ball is kicked into the air, gravity will pull it back to

- (ii) **Newton's Second Law** It states that the acceleration produced in an object due to extent force is directly proportional to the force producing it and inversely proportional to its mass. It means the acceleration depends upon the force applied and the mass of an object.

This law has an application in many games such as baseball in which, if a batter hits the ball with double the normal force, the acceleration rate of the ball will be doubled.

- (iii) **Newton's Third Law** It states that for every action, there is always an equal and opposite reaction. It describes what happens to a body when it exerts a force on another body.

This law has an application in sports such as swimming, in which a swimmer propels himself through the water because the water offers an equal counter force to oppose the action of the swimmer's hands and legs, push, thus, allowing him to move.

**31** What is centre of gravity? How can a sportsperson apply the concept of centre of gravity in sports so that they improve their performance?

**Ans** Centre of gravity of a body is an imaginary point around which the body of an object is balanced. It can be simply said to be a point where all the forces acting on the body are directed.

At this point, these forces are balanced to create the state of equilibrium.

The knowledge of the centre of gravity is essential for sports and physical education.

Sportsperson can use this knowledge to improve their performance and succeed by using the following methods

A sportsperson can become more stable by lowering his centre of gravity.

To maintain balance during a performance, the sportsperson can ensure that his centre of gravity remains over his support base.

If a sportsperson's balance is lost, he can regain it by enlarging the support base or by repositioning his centre of gravity.

For rapid movement of his body from a position of readiness, the sportsperson should position

Shifting the centre of gravity towards an approaching force will increase the sportsperson's ability to maintain balance.

When lifting or carrying an object, shift the body weight to maintain balance.

- 32** What is friction? Is it advantageous or disadvantageous in the field of games and sports? All India 2017, Delhi 2012

**Ans** The force acting along two surfaces in contact which opposes the motion of one body over the other is called the force of friction. It has a lot of importance in sports.

For example, when a cricket ball or hockey ball is hit, it moves very fast in the direction of force in the ground. After sometime, its motion becomes less and ultimately it comes at static position.

Friction has a great significance in the field of sports. Many sports require more friction and other need lesser friction.

Some of the advantages of friction with examples are as follows

- In athletics, the shoes are designed to increase friction so that better speed can be generated. The spikes have small nails to increase the friction.
- Gymnasts use lime on their palms for better grip to perform on horizontal bars to increase friction.

In these sports, friction is necessary thus considered advantageous.

Some games do not require friction and thus, friction is regarded as disadvantageous for those games. Some of the examples of disadvantages of friction are as follows

- In the games like snow skiing, the skis are designed to have minimum friction.
- In cycling, there should not be more friction between road and tyres of the cycle as the biker will have to put more effort to cycle. If there is more friction, it will be more wastage of energy of the cyclist.
- Swimmers use goggles, cap and full body swimsuit to reduce the force of friction caused by water.

- 33** Elucidate the types of friction. Delhi 2010

**Ans** Types of friction are as follows

- (i) **Static Friction** The opposing force that comes into play when one body tends to move over the another, surface, but the actual motion has not yet started, is called static friction.

- (ii) **Dynamic Friction** It is the friction between two surfaces that are in relative motion with respect to each other. It is the opposing force that comes into play when one body is actually moving over the surface of another body.

Dynamic friction may be of two types, i.e. sliding friction and rolling friction, which are as follows

- **Sliding Friction** The term sliding friction refers to the resistance created by two objects sliding against each other. This can be also called kinetic friction.

Sliding friction is intended to stop an object from moving. It takes place due to interlocking between microscopic surfaces. For example, when an ice-skater is skating.

- **Rolling Friction** The force resisting the motion of a rolling body on a surface is known as rolling friction or rolling resistance.

Rolling of ball or wheel is an example of rolling friction. It is considerably weaker than sliding friction. It takes place due to deformation of surfaces.

- (iii) **Fluid Friction** It is a friction that occurs when objects move across or through a fluid. For example, in swimming, fluid friction is witnessed as when a person is going through water and the water pulls on it to slow it down, or grabs onto it to try and have a bigger force.

# SELF ASSESSMENT

## OBJECTIVE ANSWER TYPE QUESTIONS

- Which of the following is an example of dynamic equilibrium?  
(a) Sportsperson is running  
(b) Sportsperson is taking part in gymnastics  
(c) Standing one leg  
(d) Both (a) and (b)
- Which law of motion states "for every action there is always an equal and opposite reaction?"  
(a) First                      (b) Second                      (c) Third                      (d) None of these
- Dynamic friction is the force opposing motion of one body over the surface of another body when \_\_\_\_\_.  
(a) The bodies are not in contact with each other                      (b) The bodies have not yet started moving  
(c) One body is actually moving                      (d) None of these
- Sliding friction is a form of dynamic friction applicable in the sports event of \_\_\_\_\_.
- Friction may be reduced by \_\_\_\_\_.
- \_\_\_\_\_ the bottom surface of an athlete's shoes increases friction between the shoes and the ground.
- Friction is not an important aspect in sports. State true or false.
- Physical activity is made possible by movements and motions. State true or false.

## VERY SHORT ANSWER TYPE QUESTIONS

- Give an example to show the application of Newton's third law of motion in sports.
- Explain sliding friction.
- State two instances where friction is advantageous in sports.

## SHORT ANSWER TYPE QUESTIONS

- Explain how Newton's first and second laws are applicable in a game of basketball.
- How movement of air and friction can become a disadvantage for a cyclist?
- Why athletes prefer to wear spikes while running on the track?

## LONG ANSWER TYPE QUESTIONS

- Enlist the various roles of friction in sports.
- State in brief about application of centre of gravity in sports.