8 Biomechanics and Sports

Fastrack Revision

- **Newton's Law of Motion**
  - **First Law of Motion/Law of Inertia:** This law states that a body at rest will remain at rest and a body in motion will continue to remain in motion at a constant speed and in the same direction until any external force is applied on it to change its state.
  - **Second Law of Motion/Law of Acceleration:** According to second law of motion, the rate of change in acceleration of an object is directly proportional to the force producing it and inversely proportional to its mass.
  - **Third Law of Motion/Law of Reaction:** This law states that to every action, there is an equal and opposite reaction.
- **Application of Newton's Law of Motion in Sports**
  - **First Law: Tennis:** A tennis ball will remain at rest in the court until the unbalanced force of player's hand picks it up and moves it. A tennis ball hit by the player will stay in motion until it hits the unbalanced force of opposing player's racquet.
  - **Second Law: Baseball:** A baseball hit with a swinging bat will accelerate more than a baseball that is bunted because the swinging bat has more force.
    It equal force is applied to the baseball (more mass) and t-ball (less mass), then t-ball will accelerate more.
  - **Third Law: Soccer:** When a soccer ball hits a goalie's hand, the action is the ball hitting the goalie's hand and the reaction force is the hand hitting the ball in the opposite direction.
- **Lever**
  A lever is a rigid bar used to overcome resistance when a force is applied.
  "A rigid piece transmits and modifies force or motion when forces are applied at two points, and it turns about a third."
  All lever systems are made up of four components *i.e.*, load, fulcrum, effort and lever.
  - **Load/Resistance Arm:** It is the point where the load or resistance is located.
  - **Fulcrum:** It is the point at which the lever rotates or turns and identifies the lever class by its position in relation to the other two parts. In human movement, the fulcrum is the joint that dictates the kind of action.
  - **Effort/Force:** It is the point at which the force is applied.
  - **Types of Levers:**
    There are three types/classes of levers:
    (i) First-class Lever: A first class lever has the fulcrum between the force and the resistance.
    For example: When throwing a ball. In this example, fulcrum is elbow, effort is triceps and load is arm/ball.
    (ii) Second-class Lever: A second-class lever has the load resistance between the fulcrum and the force.
    For example: When doing V-sit-up during straight push-ups. In this example fulcrum is ball of the foot, effort is arm muscle contraction and load is the body weight.
    (iii) Third-class Lever: A third-class lever has the force between the fulcrum and the resistance.
    For example: When throwing a ball.
    In this example, fulcrum is elbow joint, effort is biceps and load is arm/weight.
  - **Applications of Lever in Sports**
    A few examples of lever application in sports are:
    - **Cricket Bat (2nd class):** The fulcrum is the top of the handle, the load is the bat's body, and the force is closer to the neck of the handle.
    - **Kicking-Lower limb (3rd class):** The fulcrum at the knee joint, force at tibial tuberosity, (attachment of the quadriceps) load is the foot.
    - **Jumping-Plantar flexion of the foot (2nd class):** The load is at the toes, the fulcrum is at the heel, and force is your weight which is anterior to your heel.
    - **Looking up/down or side-to-side (1st class):** Your head is balanced on your atlanto-occipital joint, which pivots, similarly to a see-saw.
- **Equilibrium:** Equilibrium refers to the state of any object when all forces acting upon it result in zero change of motion for the object. In other words, when the sum of all forces is zero, the object is in a state of equilibrium. Equilibrium provides us balance and stability.
  - **Types of Equilibrium**

S.No	Static Equilibrium	Dynamic Equilibrium
(i)	When the sum of forces acting upon the object and sum of the movement acting upon the body is both equal to zero, then the body is said to be in static equilibrium.	When all the forces acting on an object are balanced, and the body is in motion, then the body is said to be in dynamic equilibrium.
(ii)	Static balance is maintaining equilibrium when stationary.	Dynamic balance is maintaining equilibrium when moving.
(iii)	For *e.g.*, A gymnast performing "T" position on the balancing beam, because the gymnast is not making any movement.	For *e.g.*, A gymnast doing a cartwheel during performance.

- **Application of Equilibrium in Sort**
  - Two people balancing on a see-saw.
  - Dynamic equilibrium is required by a tennis player to change her/his position after hitting a shot.
  - Boxers can lose balance if they shift their weight on heels because the centre of gravity must fall within the line of base of support for greater stability.
- **Principles of Equilibrium**

  Some of the principles are as follows:
  - The lower the centre of gravity is to the base of support, the greater will be the stability.
  - The nearer the centre of gravity is to the centre of base of support, the more will be the stability.
  - Broader is the base of support, the greater will be the stability.
- **Centre of Gravity**
  - Centre of gravity is a point at which a body balances or the point at which the weight of body is equally distributed. The centre of gravity is the average location of the weight of an object. The position of centre of gravity changes depending upon the position of the body or object.
- **Application in Sports**
  - In sports like wrestling and the athletes maintain stability by lowering the centre of gravity by bending their knees.
  - A jumper's centre of gravity must lie on the base of support for greater stability while take-off.
- **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. Generally, there are two causes of friction:
  - The irregularity or roughness of the surface.
  - The molecular forces of attraction between two surfaces in contact.
- **Types of Friction**

  There are following two types of friction in general:
  - **Static Friction:** The frictional force that comes into play when one body tends to move over the surface of the other body, but the actual motion has yet not started, is known as static friction.
  - **Dynamic Friction:** The frictional force that comes into play when one object is actually moving (sliding or rolling) over the surface of the other body, is called dynamic friction.

    It is further categorised as follows:
  - **Rolling friction:** The frictional force exerted on an object when it is rolling over some other surface or object is known as rolling friction.
  - **Sliding friction:** The frictional force exerted on an object when it is sliding over some other surface or object is known as sliding friction.
- **Advantages of Friction**
  - Athletes would not be able to walk on the surface of earth, if there is no necessary frictional force present.
  - A weightlifter rubs powder in the hands before holding the rod to increase the amount of friction between the hands and the rod. This helps to have a better grip on the rod.
  - Similarly, gymnasts use chalk power to ensure a strong and reliable grip while performing on horizontal bar, uneven bar or roman rings.
  - In track events, athletes use spikes so that they can get adequate friction from the surface and run fast.
- **Disadvantages of Friction**
  - In snow skiing, the skiis are designed to have minimum friction for better performance.
  - In cycling, the sportsperson must not experience any frictional force through the surface, otherwise it may result in wastage of energy.
  - In football, cricket, hockey etc. , friction is responsible for decreased speed of playing ball on ground.
- **Projectile**
  - An object thrown into the space either horizontally or at an acute angle under the action of gravity is called a projectile.
- **Factors Affecting Projectile Trajectory**
  - **Angle of Projection:** A projectile when released at an angle of 45° makes a parabolic path and covers the maximum distance, as compared to when it is released at any other angle (the initial velocity having been kept constant).
  - **Initial Velocity:** The distance traversed by the projectile also depends upon the velocity by which it is thrown. If the velocity is more, it would cover greater distance as compared to when thrown by a lesser velocity.
  - **Gravity:** The trajectory of the projectile is also affected by the gravitational pull of the earth. It directly depends upon the weight of the object thrown. The greater the weight of the object, the greater would be the gravitational resistance or pull.
  - **Air Resistance:** When a projectile moves through the air, it is slowed down by air resistance. Air resistance decreases the horizontal component of a projectile. There are following factors which are related to the amount of air resistance acting on a projectile:
    - Surface of the Object
    - Speed
    - Mass
    - Surface to Volume Ratio
  - **Spin:** The spin also affects the flight of the projectile. The amount and direction of spin acting on a projectile directly affects the distance covered or travelled by a projectile.

Practice Exercise

Multiple Choice Questions

Q 1. Which law amongst the given ones is known as the first law of motion? *(CBSE SQP 2021 Term-1)*

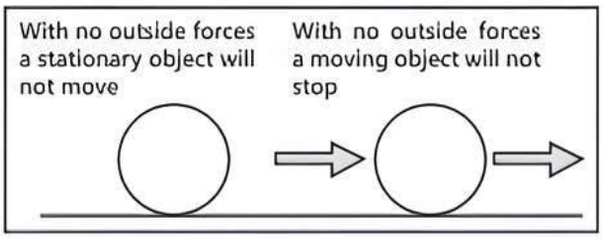
Or **Newton's first law of motion is known as:** *(CBSE SQP 2021 Term-1)*

a. Law of inertia
b. Law of acceleration
c. Law of reaction
d. Gravitational pull

Q 2. The law of acceleration is also known as: *(CBSE 2020)*

a. Law of inertia
b. Law of action and reaction
c. Law of momentum
d. Boyle's above

Q 3. Identify the given below: *(CBSE SQP 2023-24)*



a. First Law of Motion
b. Second Law of Motion
c. Third Law of Motion
d. Law of Effects

Q 4. In law of acceleration, acceleration of an object is inversely proportionate to its ..... *(CBSE SQP 2022-23)*

a. Force
b. Mass
c. Speed
d. Size

Q 5. Who gave laws of motion? *(CBSE SQP 2021 Term-1)*

a. Galileo
b. Pascal
c. Newton
d. Darwin

Q 6. Starting a throwing event in athletics is an example of which law of motion? *(CBSE SQP 2021 Term-1)*

a. First law of motion
b. Second law of motion
c. Third law of motion
d. First and Third law of motion

Q 7. Physical education teacher of ABC school was teaching the students about Newton's laws of motion. While explaining he showed the students this picture and tried to explain how there is a difference in the speed of an object due to their weight. Can you name the law? *(CBSE SQP 2021 Term-1)*

a. Newton's first law of motion
b. Newton's second law of motion
c. Newton's third law of motion
d. Action reaction

Q 8. 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-1)*

a. Law of Inertia
b. Law of acceleration
c. Law of reaction
d. Both a. and c.

Q 9. Application of Newton's laws of motion is very useful in sports. In this context, acceleration is related to: *(CBSE 2021 Term-1)*

a. Newton's first law of motion
b. Newton's third law of motion
c. Newton's second law of motion
d. Both a. and b.

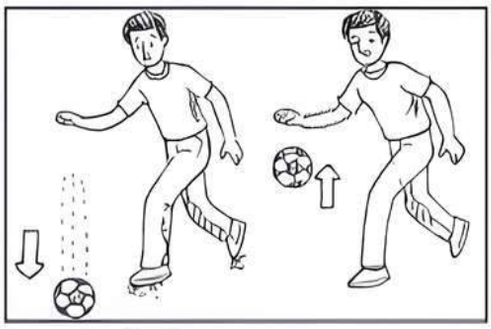
Q 10. Newton's third law of motion is known as: *(CBSE 2021 Term-1)*

a. Law of action and reaction
b. Law of inertia
c. Law of acceleration
d. Law of gravity.

Q 11. Which Newton's law of motion is depicted through this picture? *(CBSE 2021 Term-1)*

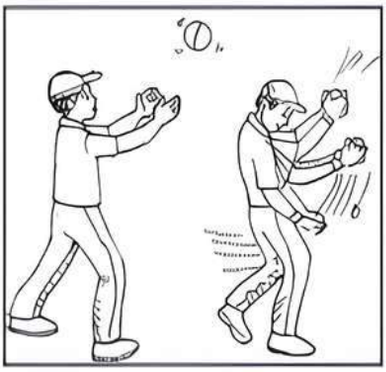
a. Newton's first law of motion
b. Newton's second law of motion
c. Newton's third law of motion
d. Both a. and b.

Q 12. Which Newton's law of motion is depicted through the picture? *(CBSE 2021 Term-1)*



a. Newton's third law
b. Newton's second law
c. Newton's first law
d. Newton's first and second law

Q 13. Identify the law of motion, shown in the illustration: *(CBSE 2021 Term-1)*



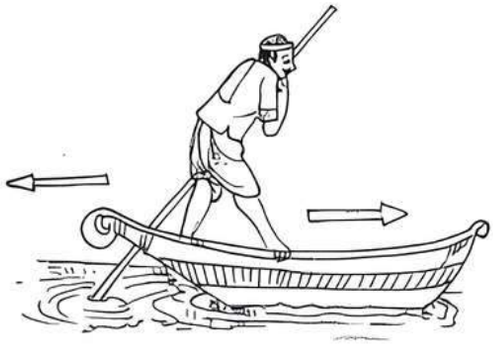
a. Law of Inertia
b. Law of action and reaction
c. Law of acceleration
d. Both b. and c.

Q 14. Physical education teacher of XYZ school explained how Newton's law of motion are used in sports. She explained while dribbling in Basket-ball.

How the laws can be helpful?

Which law of motion is shown in picture:

(CBSE 2021 Term-1)

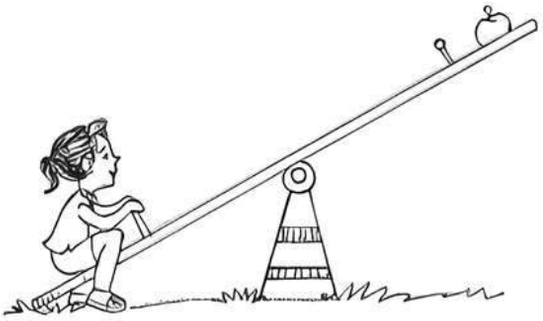


a. Law of Inertia
b. Law of acceleration
c. Law of action and reaction
d. Both a. and b

Q 15. The three basic components of a lever are:

a. Mass, Weight and velocity
b. Force, Fulcrum and Load
c. Fulcrum, Resistance and Effort
d. Both b. and c.

Q 16. What type of lever is depicted in the picture?



a. 1st Class lever
b. 2nd Class lever
c. 3rd Class lever
d. None of these

Q 17. Cartwheel in gymnastics is an example of .....

(CBSE SQP 2022-23)

a. Static Equilibrium
b. Dynamic Equilibrium
c. Active Equilibrium
d. Passive Equilibrium

Q 18. The position of centre of gravity changes depending upon the :

a. position of force
b. position of the body
c. position of intersection of force
d. position of stability

Q 19. Which type of friction is applicable in sports like cricket, hockey, etc.

a. Static friction
b. Sliding friction
c. Rolling friction
d. None of these

Q 20. Which of the following is not an example of projectile motion?

a. A stone thrown in any direction
b. A stone thrown horizontally from a building
c. A car moving in a straight line
d. A bullet fired from a gun.

Q 21. Which of the following is NOT the factor affecting projectile trajectory? *(CBSE 2023)*

a. Gravity
b. Angle of Release
c. Buoyant Force
d. Air Resistance

Assertion & Reason Type Questions

Directions (Q. Nos. 22-25): *There are two statements marked as Assertion (A) and Reason (R). Read the statements and choose the appropriate option from the options given below:*

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

Q 22. Assertion (A): "A change in the acceleration of an object is directly proportional to the force producing it and inversely proportional to its mass."

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

(CBSE SQP 2021 Term-1)

Q 23. Assertion (A): A high jumper can jump higher off a solid surface.

Reason (R): The solid surface opposes his/her body with as much force as he/she is able to generate in contrast to sand or any other unstable surface.

Q 24. Assertion (A): The magnitude of the force of friction depends on the roughness of the surface.

Reason (R): When both the surfaces are smooth, the force of friction reduces to almost zero.

Q 25. Assertion (A): The path followed by a projectile is called trajectory.

Reason (R): The distance covered by an object does not depends on the initial velocity of the projectile.

Answers

1. (a) Law of Inertia
2. (c) Law of momentum
3. (b) Second Law of Motion
4. (b) Mass
5. (c) Newton
6. (a) First law of motion

7. (b) Newton's second law of motion
8. (d) Both a. and c.
9. (c) Newton's second law of motion
10. (a) Law of action and reaction
11. (a) Newton's first law of motion
12. (b) Newton's second law
13. (c) Law of acceleration
14. (c) Law of action and reaction
15. (d) Both b. and c.
16. (a) 1st Class lever
17. (b) Dynamic Equilibrium
18. (b) position of the body
19. (c) Rolling friction
20. (c) a car moving in a straight line
21. (c) Buoyant Force
22. (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
23. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
24. (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
25. (c) Assertion (A) is true, but Reason (R) is false.

Case Study Based Questions

Case Study 1

Read the following passage and answer the following questions.

While talking about Newton's laws of motion and their application in sports, a Physical Education teacher gave examples from cycling, swimming and cricket. He also told that while cycling, the cyclists only move when they start to pedal and stop only when they apply brakes. While swimming, the swimmers use the wall of the pool to generate the force needed to take off.

Q 1. What law is applied to cyclists?
a. Law of inertia b. Law of acceleration
c. Law of reaction d. Law of momentum

Q 2. Which law is in force when the swimmer pushes off the wall of the swimming pool to start the race?
a. Law of inertia b. Law of acceleration
c. Law of reaction d. Law of momentum

Q 3. Which law is in play when the ball is hit by the batsman?
a. Law of inertia b. Law of acceleration
c. Law of reaction d. law of momentum

Answers

1. (a) 2. (c) 3. (c)

Case Study 2

Read the following passage and answer the following questions.

In Equestrian sport, when the horse suddenly stops, then the rider falls forward. Based on this, answer the following questions.

Q 1. Rider's falling forward can be related to which law of Newton?
a. First b. Third
c. Second d. None of these

Q 2. State the Law of Motion being discussed in the above question.
a. Body at rest will remain at rest unless acted upon by an external unbalanced force.
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.

Q 3. 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

Answers

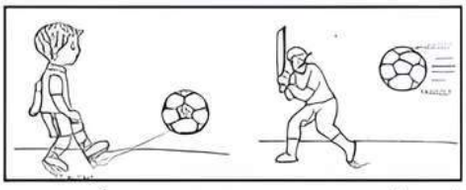
1. (a) 2. (a) 3. (c)

Case Study 3

Read the following passage and answer the following questions.

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.

(CBSE SQP 2022-23)



Q 1. 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?
Q 2. Among the above given pictures, Newton's 3rd law is depicted in .....
Q 3. Newton's second law is also known as .....
Q 4. The study of human body and various forces acting on it is .....
Or **A high jumper can jump higher off a solid surface because it opposes his or her body with as much force as he or she is able to generate. This example refers to which law of motion?**

Answers

Ans. 1. Newton's third law of motion
2. 1st picture
3. Law of Acceleration
4. Kinesiology
Or Newton's third law of motion

Case Study 4

Read the following passage and answer the following questions.

During her gymnastics practice, Zoya was finding it difficult to maintain her balance on the balancing beam. Her coach tried to explain to her about basic principles of equilibrium. *(CBSE SQP 2023-24)*

According to the principles of equilibrium centre of gravity plays a very important role.

Q 1. The nearer the center of gravity to the center of the base of support the more will be the .....

Q 2. The position of the centre of gravity changes depending upon the .....

Q 3. The sum of all the vertical and horizontal forces acting on the body must be .....

Q 4. Centre of gravity is the average location of an object's .....

Or **When the sum of force acting upon the object and sum of the movement acting upon the body is both equal to zero then the body is said to be in .....**

Answers

Ans. **1.** Stability
2. position of the body
3. zero
4. Weight
Or Equilibrium

Very Short Answer Type Questions

Q 1. State the law of reaction.

Ans. Law of reaction states that, for every action, there is an equal and opposite reaction.

Q 2. What do you understand by equilibrium? Name the types of equilibrium.

Ans. Equilibrium refers to the state of any object when all forces acting upon it result in zero charge of motion for the object. The two types of equilibrium are:
(i) Static equilibrium
(ii) Dynamic equilibrium

Q 3. Define friction and name its types. *(CBSE 2017)*

Ans. Friction is the force resisting the relative motion of two bodies sliding or rolling against each other. The two types of friction are:
(i) Static Friction
(ii) Dynamic Friction

Q 4. What is 'dynamic friction'? *(CBSE 2016)*

Ans. The frictional force that comes into play when one object is actually moving (sliding or rolling) over the surface of other body is called dynamic friction.

Q 5. Define centre of gravity.

Ans. Centre of gravity is a point at which a body balances or the point at which the weight of the body is equally distributed.

Q 6. An object is thrown into the space either horizontally or at an acute angle under the action of gravity is called a projectile. Name the two forces which act on a projectile. *(CBSE 2017)*

Ans. Gravitational force and air resistance.

Q 7. To cover the maximum distance at what angle should a projectile be released?

Ans. Projectile should be released at an angle of 45° for achieving maximum distance.

Short Answer Type-I Questions

Q 1. Elucidate Newton's law of inertia.

Ans. According to Newton's law of inertia, "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 acted upon by an external unbalanced force".

Law of Inertia essential makes two important point:
(i) An object that is not moving will not move until a net force acts upon it, and
(ii) An object that is in motion will not change its velocity until a net force acts upon it.

Q 2. Give two applications of centre of gravity in sports.

Ans. The two applications of centre of gravity in sports are as follows:
(i) In sports like wrestling, the athletes maintain stability by lowering the centre of gravity by lending their knees.
(ii) A jumper's centre of gravity must lie on the base of support for greater stability while take-off.

Q 3. Differentiate between rolling and sliding friction.

Ans. Difference between rolling and sliding friction is as follows:

S. No.	Basis of Difference	Rolling Friction	Sliding Friction
(i)	Definition	The frictional force exerted on an object when it is rolling over some other object is called rolling friction.	The frictional force exerted on an object when it is sliding over the surface of some other object is called sliding friction.
(ii)	Example	A ball hit by a hockey or a cricket bat.	A water drop moving slowly over a wooden surface or while ice-skating.

Q 4. List any two advantages of friction in games and sports.

Ans. The two advantages of friction in games and sports are as follows :

(i) In hockey, badminton and tennis, grip tapes are used by the player to increase friction.

(ii) In shot put, javelin throw, gymnastics, magnesium powder is used to increase friction.

Q 5. Explain any two factors that affect a projectile trajectory.

Ans. Factors that affect projectile trajectory are as follows:

(i) Angle of Projection: A projectile when released at an angle of 45° makes a parabolic path and covers the maximum distance, as compared to when it is released at any other angle (initial velocity kept constant).

(ii) Initial Velocity: The distance traversed by the projectile also depends upon the velocity by which it is thrown. If the velocity is more, it would cover greater distance as compared to when thrown by a lesser velocity.

Short Answer Type-II Questions

Q 1. With suitable examples explain the application of Newton's law in sports. *(CBSE 2020)*

Ans. Newton's law of motion are as follows:

(i) Newton's First Law of Motion (Law of Inertia): According to the first law of motion, A body at rest, remains at rest and a body in uniform motion, remains in motion at a constant speed and in the same direction, until and unless acted upon by an external force. For example, if there is no frictional force, acting on a cricket ball hit by a batsman, the ball may not stop forever. As soon as the ball hits the ground, the frictional force is initiated. Slowly, as the ball moves ahead, its speed slows down due to surface friction and after some time, it stops.

(ii) Newton's Second Law of Motion (Law of Acceleration): According to the second law of motion, a change in acceleration of an object is directly proportional to the force producing it and inversely proportional to its mass.

For example, an athlete will require more force and strength to throw a hammer weigh 5 kg., as compared to when he/she will throw a hammer weighing 3 kg. Also, the acceleration produced in the hammer weighing 5 kg, will be greater than that produced in the lighter one. Similarly, a hockey ball hit by a greater force will accelerate faster, as compared to the one hit with a minimal force.

(iii) Newton's Third Law of Motion (Law of Reaction): According to the third law of motion, for every action, there is an equal and an opposite reaction. For Example, the force, with which the bullet is fired from a shotgun or a rifle, is always equal to the force by which the gun or rifle jerks back.

TiP

The students must learn the correct statement of Newton's law of motion along with their application.

COMMON ERROR

Students are able to state the laws but are not able to explain their application in sports.

Q 2. Differentiate between static and dynamic equilibrium.

Ans. Difference between static and dynamic equilibrium is as follows:

S.No	Static Equilibrium	Dynamic Equilibrium
(i)	When the sum of forces acting upon the object and sum of the movement acting upon the body is both equal to zero, then the body is said to be in static equilibrium.	When all the forces acting on an object are balanced, and the body is in motion, then the body is said to be in dynamic equilibrium.
(ii)	Static balance is maintaining equilibrium when stationary.	Dynamic balance is maintaining equilibrium when moving.
(iii)	For *e.g.*, A gymnast performing 'T' position on the balancing beam, because the gymnast is not making any movement.	For *e.g.*, A gymnast doing a cartwheel during performance.

Q 3. What are the three principles of equilibrium? Also, give application of equilibrium in sports.

Ans. The three principles of equilibrium are as follows:

(i) The lower the centre of gravity is to the base of support, the greater will be the stability.

(ii) The nearer the centre of gravity is to the centre of base of support, the more will be the stability.

(iii) Broader is the base of support, the greater will be the stability.

Application of equilibrium in sport:

(i) Two people balancing on a see-saw.

(ii) Dynamic equilibrium is required by a tennis player to change her/his position after hitting a shot.

(iii) Boxers can lose balance if they shift their weight on heels because the centre of gravity must fall within the line of base of support for greater stability.

Q 4. Friction is categorised into how many types? Explain them in brief with example.

Ans. There are generally two types of friction:

(i) Static Friction: The actual frictional force that comes into play when one body tends to move over the surface of the other body, but the actual motion has yet not started, is known as static friction.

For example, pushing a wall

(ii) **Dynamic Friction:** The actual frictional force that comes into play when one object is actually moving (sliding or rolling) over the surface of the other body, is called dynamic friction.
For example, riding a motorcycle, a child sliding down a slide in a park.

Q 5. Explain any three factors which are related to the amount of air resistance acting on a projectile.

Ans. Following factors are related to the amount of air resistance acting on a projectile:

(i) The amount of air resistance depends on the surface of the object. If the surface of object is rough, the air resistance will be greater.

(ii) Air resistance depends on the mass of the object. If the mass of the object is smaller then there will be more air resistance.

(iii) The larger the surface to volume ratio, the more air resistance will affect the object.

Long Answer Type Questions

Q 1. With the help of suitable examples, discuss the application of Newton's Laws of Motion in sports. *(CBSE SQP 2023-24)*

Ans. Application of Newton's Law of Motion in Sports:

(i) First Law: Tennis: A tennis ball will remain at rest in the court until the unbalanced force of player's hand picks it up and moves it. A tennis ball hit by the player will stay in motion until it hits the unbalanced force of opposing player's racquet.

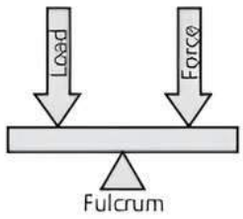
(ii) Second Law: Baseball: A baseball hit with a swinging bat will accelerate more than a baseball that is bunted because the swinging bat has more force.
It equal force is applied to the baseball (more mass) and t-ball (less mass), then t-ball will accelerate more.

(iii) Third Law: Soccer: When a soccer ball hits a goalie's hand, the action is the ball hitting the goalie's hand and the reaction force is the hand hitting the ball in the opposite direction.

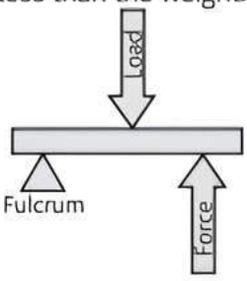
Q 2. Describe the types of lever with the help of their diagrams.

Ans. Types of lever are as follows:

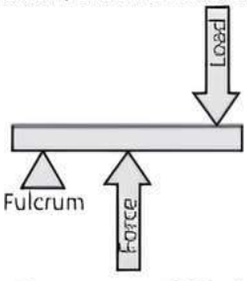
(i) First-class Lever: A first-class lever has the fulcrum between the force and the resistance. This class fulcrum may be moved about along the lever, thereby changing the relative lengths of the force arm and the resistance arm. If the fulcrum is placed close to the resistance, the force arm is length, and hand and less force need to be applied to move the resistance, but force must be applied through a long distance to lift the resistance a short distance. Conversely, a shortened force arm requires more excellent force application, but there is a gain in speed and range of motion at the resistance end.



(ii) Second-class Lever: A second-class lever has the load resistance between the fulcrum and the force. In this class of levers, movement of the fulcrum will increase or decrease both the force arm and the resistance arm. The force arm is always the longer of the two, and therefore the force needed to lift resisting weight will always be less than the weight.



(iii) Third-class Lever: A third-class lever has the force between the fulcrum and the resistance. In this class of lever, the force arm is always shorter than the resistance arm, and so a large amount of force must be applied, but the resistance is moved through a much longer range of motion than the force application. In the human body, the most common class of lever is the thread. His is particularly important in the movements of the limps because the desired results are often those of speed or range of motion, albeit at the expense of force.



Q 3. What are the various types of friction? 'Friction is a necessary evil'. Justify your answer.

Ans. There are following two types of friction in general:

(i) Static Friction: The frictional force that comes into play when one body tends to move over the surface of the other body, but the actual motion has yet not started, is known as static friction.

(ii) Dynamic Friction: The frictional force that comes into play when one object is actually moving (sliding or rolling) over the surface of the other body, is called dynamic friction.

Friction is Necessary: It reduces the efficiency of work done. For Example, athletes use spikes and footballers use studs, so that they can get appropriate friction from the surface and run fast.
A weightlifter rubs lime powder on his hands before holding the rod and performing jerk and snatch.

In the same way, even the gymnasts do the same before performing on horizontal bar, uneven bar, or roman rings, in order to get friction.

Friction is an Evil: It is an evil because it results in wastage of energy. Also, we have to spend a lot of money to move things due to friction. For example, in cycling there should be minimum friction between road and types of cycles. If there is more friction, it will result in low performance and wastage of energy of the cyclist. Swimmers, also use goggles, cap and swimsuit to reduce the force of friction caused by water.

TiP

Many students are not able to understand the question and explain only the evil effects of friction.

Q 4. What is Friction? Write the advantages and disadvantages of friction by giving suitable examples from sports. *(CBSE 2023)*

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

Advantages of Friction:

(i) Athletes would not be able to walk on the surface of earth, if there is no necessary frictional force present.

(ii) A weightlifter rubs powder in the hands before holding the rod to increase the amount of friction between the hands and the rod. This helps to have a better grip on the rod.

(iii) Similarly, gymnasts use chalk power to ensure a strong and reliable grip while performing on horizontal bar, uneven bar or roman rings.

(iv) In track events, athletes use spikes so that they can get adequate friction from the surface and run fast.

Disadvantages of Friction:

(i) In snow skiing, the skiis are designed to have minimum friction for better performance.

(ii) In cycling, the sportsperson must not experience any frictional force through the surface, otherwise it may result in wastage of energy.

(iii) In football, cricket, hockey, etc., friction is responsible for decreased speed of playing ball on ground.

Q 5. What is projectile? Explain any two factors affecting projectile with the help of examples from sports. *(CBSE SQP 2022-23)*

Ans. Any object thrown into the space either horizontally or at an acute angle under the action of gravity is called a projectile.

Factors affecting Projectile Trajectory:

(i) Angle of Projection: A projectile when released at an angle of 45° makes a parabolic path and covers the maximum distance, as compared to when it is released at any other angle (the initial velocity having been kept constant).

(ii) Initial Velocity: The distance traversed by the projectile also depends upon the velocity by which it is thrown. If the velocity is more, it would cover greater distance as compared to when thrown by a lesser velocity.

Chapter Test

Multiple Choice Questions

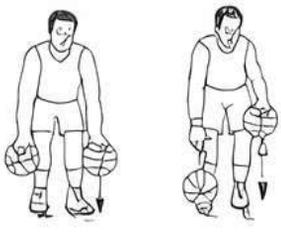
Q 1. Centre of gravity is the average location of the ..... of an object *(CBSE 2023)*

a. weight b. force
c. balance d. velocity

Q 2. Friction is a :

a. magnetic force b. non-contact force
c. contact force d. None of these

Q 3. Physical education teacher of BP School was teaching the students about Newton's Law of Motion. While explaining he showed students this picture and tried to explain how basketball comes up with different forces from the floor due to different forces exerted on the ball. Can you name the law?



a. Newton's first law of motion
b. Newton's second law of motion
c. Newton's third law of motion
d. Law of acceleration

Q 4.

During the physical education class, Newton's Laws of Motion and their practical application in sport events was discussed. While discussing, the teacher showed this picture to the students and tried to explain how a swimmer exerts a force on the wall and accelerates in the opposite direction. Can you name the law?

a. Newton's third law of motion
b. Newton's first law of motion
c. Newton's second law of motion
d. Law of inertia

Q 5. If the horizontal range of a projectile is maximum then the angle of the projectile must be ..... with horizontal.

a. 90° b. 60°

c. 45° d. 30°

Assertion and Reason Type Questions

Directions (Q. Nos. 6-7): *There are two statements marked as Assertion (A) and Reason (R). Read the statements and choose the appropriate option from the options given below:*

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

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

c. Assertion (A) is true, but Reason (R) is false.

d. Assertion (A) is false, but Reason (R) is true.

Q 6. **Assertion (A): Friction resists the sliding or rolling of one solid object over another.**
Reason (R): Friction acts in the direction of the object in motion.

Q 7. **Assertion (A): In dynamic equilibrium, all forces acting on an object are balanced and body is at rest.**
Reason (R): A fan rotating with uniform speed is an example of dynamic equilibrium.

Case Study Based Question

Q 8. **Read the following passage and answer the following questions.**

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.

(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. Law of reaction b. Law of inertia

c. Law of acceleration d. None of these

Very Short Answer Type Questions

Q 9. **Define static equilibrium.**

Q 10. **Discuss how does initial velocity affect projectile trajectory?**

(i) Blood flow

(ii) Blood volume

Short Answer Type-I Questions

Q 11. **How Newton's first and second law of motion be applied in sports?**

Q 12. **Define the following terms:**

(i) Centre of gravity

(ii) Projectile

Q 13. **What is sliding friction? Explain by giving suitable example.**

Short Answer Type-II Questions

Q 14. **Enumerate the laws of motion.**

Q 15. **Define equilibrium. What are the applications of equilibrium in games/sports?**

Q 16. **Discuss any three factors affecting projectile trajectory.**

Long Answer Type Questions

Q 17. **What is friction? Explain its types. How is friction advantageous or disadvantageous in the field of sports? Explain with suitable examples.**

Q 18. **Explain the application of law of reaction in different sports.**