

## CHAPTER 9

# BIOMECHANICS IN SPORTS

### VERY SHORT ANSWER QUESTIONS (30 WORDS - 1 MARK)

**1. Define the term biomechanics.**

**Ans.** Biomechanics is defined as systematic study of mechanics of body joints. According to Wikipedia, "Biomechanics is the study of the structure and function of biological system of humans."

**2. Name the laws of motion.**

**Ans.** There are three laws of motion, i. 1st

law of motion or law of inertia

ii. 2nd law of motion or law of acceleration

iii. 3rd law of motion or law of reaction

**3. What is a lever?**

**Ans.** Lever is a rigid bar which is capable of rotating about a fixed point called the fulcrum.

**4. While walking, which law of motion is used?**

**Ans.** While walking third law of motion, i.e. law of reaction is used.

**5. What do you understand by equilibrium?**

**Ans.** Equilibrium is defined as a state of balance or a stable situation, where opposite forces cancel each other out and where no changes are occurring.

**6. What are the different types of equilibrium?**

**Ans.** There are two types of equilibrium. Dynamic equilibrium and static equilibrium.

**7. What is a force?**

**Ans.** Force can be defined as a push or pull by one body acting upon another. Force is a product of mass and acceleration of an object or person.

**8. What is centre of gravity?**

**Ans.** Centre of gravity is that point in a body or system around which its mass or weight is evenly distributed or balanced and through which the force of gravity acts.

**9. Why do we lean forward while climbing up a hill?**

**Ans.** We lean forward while climbing up a hill to keep the centre of gravity low to maintain stability.

**10. Which law of motion helps an athlete to take a quick start of a 100m race?**

**Ans.** First law of motion, i.e. law of inertia helps athlete to take a quick start of a 100m race.

**11. Which type of lever is used while we curl our biceps?**

**Ans.** Class III lever is used while we curl our biceps.

**12. Who will have greater stability?**

a. A fat person or a thin person of same height?

b. A girl standing in stand at ease position or a girl standing on one leg?

**Ans.** a. A fat person

b. A girl standing in stand at ease position.

## CHAPTER 9

# BIOMECHANICS IN SPORTS

### SHORT ANSWER QUESTIONS

(60 WORDS-3 MARKS)

**1. Explain dynamic equilibrium.**

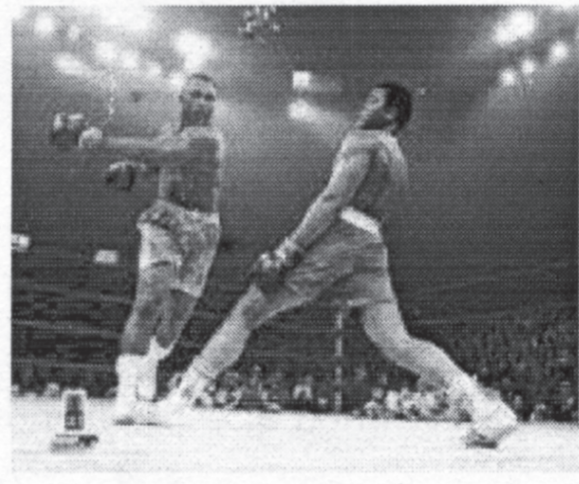
**Ans.** Dynamic stability is balancing the body during movement.

It frequently happens that the line of gravity of an athlete will fall outside the base of support for movement.

For example, in a sprint start, the body weight is ahead of the supporting foot but before the body can fall forward the other foot moves ahead to provide support and the process repeats itself.

A man carrying heavy bucket in his right hand leans towards his left hand side to maintain equilibrium.

While climbing up a hill the climber bend forward so that he does not fall. The equilibrium is maintained by bringing the CG down.

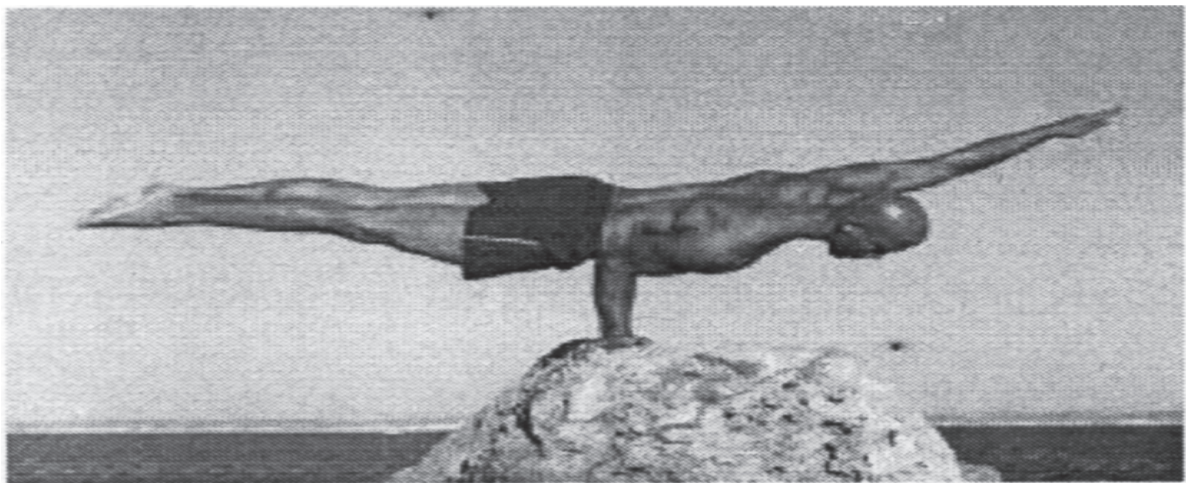


## 2. What is static equilibrium?

**Ans.** A body is said to be in stable equilibrium if it comes back to its original position when it is slightly displaced. Static stability is very important in shooting, archery and hand stand in gymnastics, etc.

Stable objects generally have wide bases and low CG.

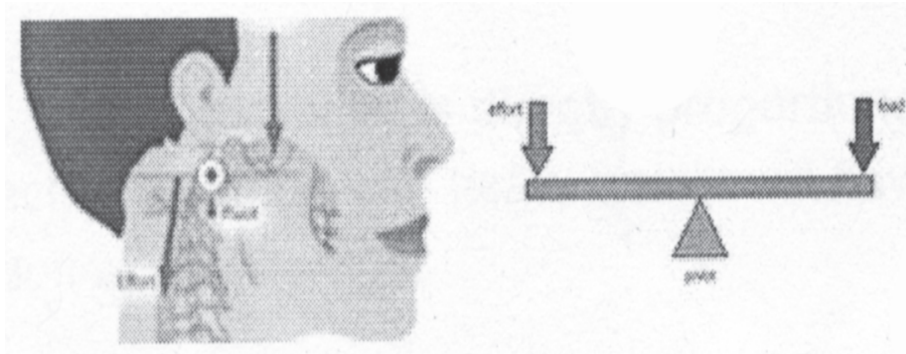
Bottom of the ship is made heavy to keep CG as low as possible. This makes the ship stable



## 3. Give example of each type of lever which our body uses during various activities.

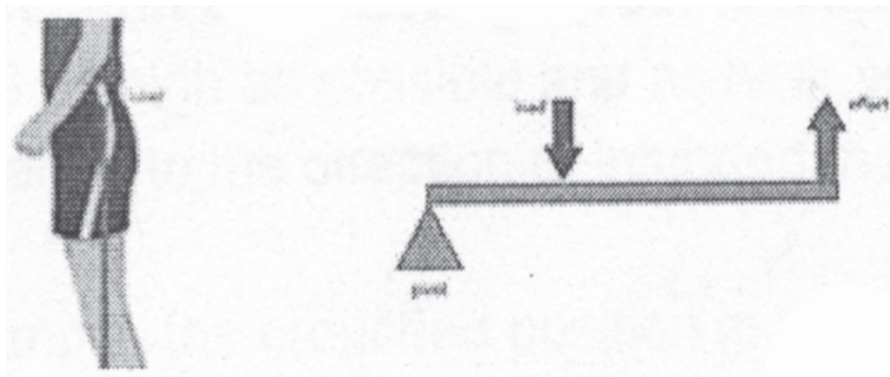
**Ans.** Followings is the example of class I lever which is used by our body.

Our skull is the lever arm and the neck muscles at the back of the skull provide the force (effort) to hit football while we lift our head up against the football (load). When the neck muscles relax, our head nods/hits forward.



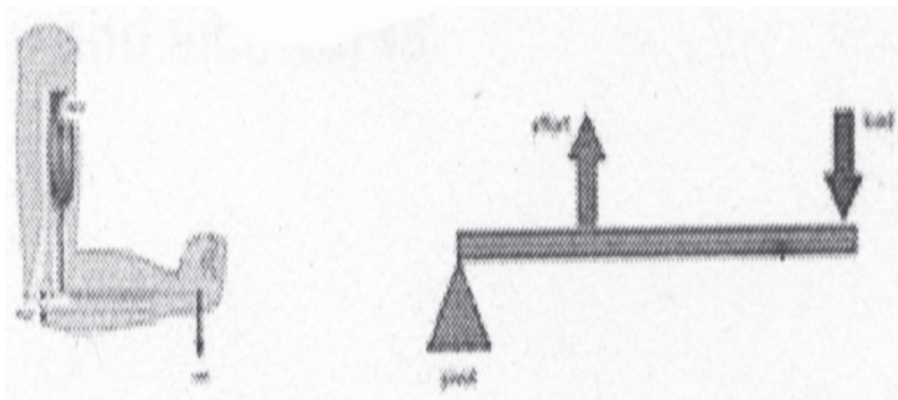
Following is the example of class II lever which is used by our body.

Our calf muscles and Achilles tendon provide the effort when the calf muscle contracts. The load is our body weight and is lifted by the effort (muscle contraction).



Following is the example of class III lever which is used by our body.

The biceps muscle provides the effort (force) and bends the forearm against the weight of the forearm and any weight that the hand might be holding.



## BIOMECHANICS IN SPORTS

### LONG ANSWER QUESTION (150 WORDS—5 MARKS)

1. Explain in detail the principle of stability and its uses in sports.

**Ans.** i. **Broad base of support:** for greater stability increase the area of the base and lower the centre of gravity as much as is consistent with the activity involved. Examples:

- a. a basketball player stops, spreads his feet wide as shoulder line and lowers his CG to dodge the opponent.
- b. Defence position of the player in volleyball.
- c. Wide stance of a golfer.
- d. tackling position of a player in football.

ii. **Stability is directly proportional to the weight of the body:** the object or a person with heavy weight will have greater stability as compared to person with less weight.

Example: it is difficult to move a heavier person as compared to less heavier person.

On the basis of this principle, wrestling, boxing, judo, etc. are organized according to different age groups.

iii. **Direction of an acting force:** to start quickly in one direction, keep the CG as high as possible and as near as possible to the edge of the base nearest to the direction of intended motion.

Example: the crouched position in starting a race, the CG is kept high by not bending the knees extremely and by keeping the hips high, also the lean of the body is towards the hands so that the weight rest on the hands. From this position, the movement hands are raised from the ground; motion starts by reason of the pull gravity. This pull is added to the force exerted against the starting block by the feet and thus aids in a quick start.

iv. **When the body is free in the air, if the head and feet move down, the hip move up and vice versa.**

Example:

- a. This principle is applied in the high jump in western or velley roll technique at the take of, the head and one foot is thrust up as high as possible. As the head and one leg clear the bar, they are dropped which raises the hips to clear the bar. As the hips are lowered, the opposite leg is raised to clear the bar.
- b. This is also used in pole vault, hurdles and jackknife, dive in swimming.

**2. State the three law of motion with suitable examples of its application in sports.**

**Ans. FIRST LAW OF MOTION OR LAW OF INERTIA**

According to first law of motion an object at rest will remain at rest or an object in motion will remain at motion at constant velocity unless acted upon by a force.

It also gives the idea that to change the state of rest or uniform motion of a body in a straight line some external agency is needed. This agency is called force.

Example:

- a. A moving football slows down and then stops often sometime.  
It comes to rest due to the friction between the ground and the ball.
- b. To take start in sprint races, to lift the opponent in wrestling, to start hammer throw.

◆ **SECOND LAW OF MOTION (The Law of Acceleration)**

According to Newton's second law of motion, the rate of change of momentum of a body is directly proportional to the impressed force and takes place in the direction of force.

Example:

- a. A cricket player while catching a ball moves his hands backwards. Initially the ball is moving with a certain velocity. The player has to apply a retarding force to bring the ball to rest in his hands.
- b. In baseball player hits the ball hard to throw it far away.

◆ **THIRD LAW OF MOTION**

According to the Newton's third law of motion, to every action there is always an equal and opposite reaction.

Example:

- a. The swimmer pushes the water in the backward direction with a certain force. Water pushes the man forwards with an equal and opposite force.
- b. Walking: when a person walks on the road, he presses the ground in backward direction and the ground exerts an equal and opposite force on the person in the forward direction.
- c. Shooting: when a bullet is fired from a rifle with a certain force (action) there is an equal and opposite force exerted on the rifle in the backward direction (reaction)

**3. What do you know about centripetal force and centrifugal force? Explain its application in sports.**

**Ans.** Centripetal force: this is the force that pushes or pulls an object towards the axis of rotation in order to make it follow a curve or circular pathway. When a player swings a bat, he applies centripetal force to make that bat follow the arc of swing.

Centrifugal force: this is the force that pushes or pulls an object outward from the axis of rotation. This force is equal and opposite of the centripetal force.

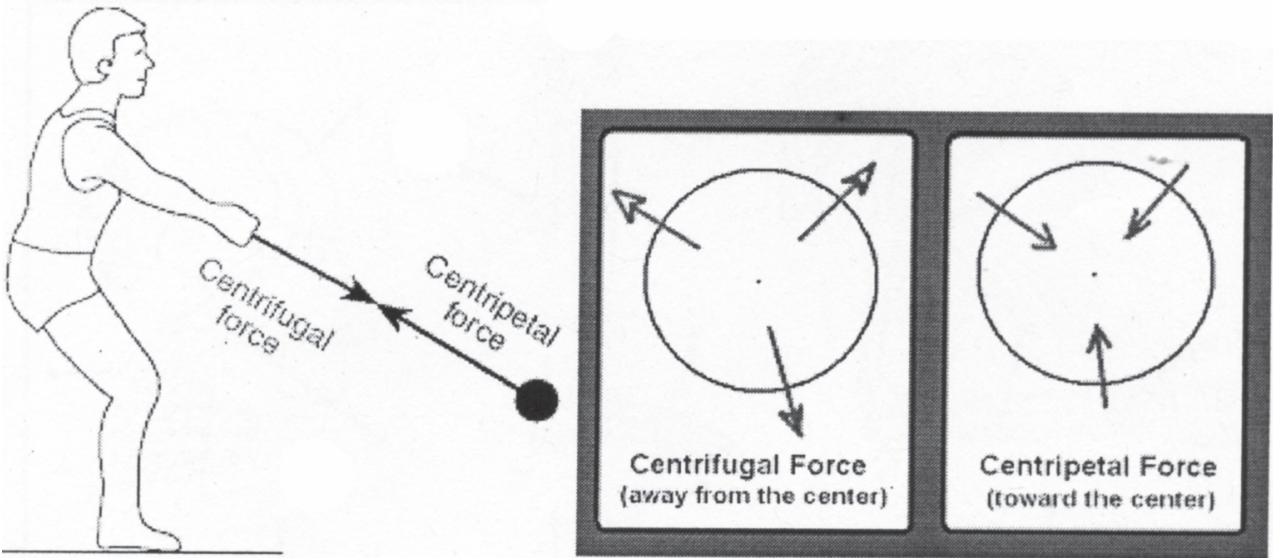
Centripetal and centrifugal force have innumerable application in sports like,

Centripetal force is needed by the player to maintain his grip. If the rotational momentum is more, the centrifugal force could cause the player to lose his grip and the bat may go of the hand.

These forces act when a runner takes a sharp bend leans inward to obtain the necessary centripetal force.

A cyclist going round the curve leans towards the centre of the curve in order to get necessary centripetal force.





4. What do you know about lever? What are different types of levers. Explain the application of lever in sports.

**Ans.** LEVER

Lever is a rigid bar which is capable of rotating about a fixed point called the fulcrum.

Example: - see-saw, scissors, pulley etc.

Skeletal system also acts like lever.

**CLASS I LEVER** - A first class lever has the fulcrum located between the force and the resistance.

Example- See-saw, a pair of scissors, bicycle brake. Rowing: in rowing, application of the force on the oars at the axis.

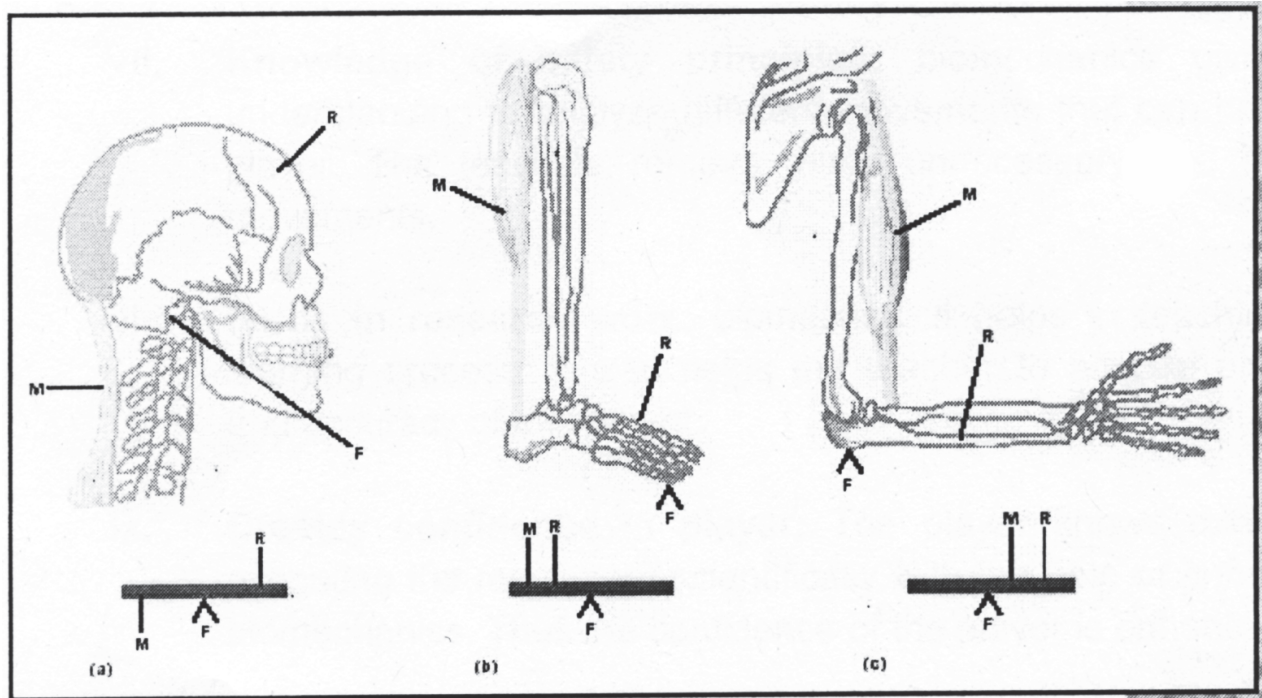
**CLASS II LEVER** - A second class lever has the load or resistance located between the fulcrum and the force.

Example- wheel barrow, punching machine,

Straight pushups, calisthenics, lifting of legs from the ground, etc.

**CLASS III LEVER** - A third class lever has the force located between the fulcrum and the resistance.

Example- baseball bat, Tennis racket, boat-paddles, curling of biceps, etc.



**5. Elucidate the importance of biomechanics in sports.**

**Ans. i. Improves performance in sports:** principles of biomechanics tell us about right techniques, effective and result oriented posture to get more efficient results by applying minimum muscular force which in turn improves performance in sports.

**ii. Improvement in technique:** with the help of biomechanical principles the physical education teacher corrects the mistakes. This helps in improving the game and performance of the player.

**iii. Development of improved sports equipment:** the principles of biomechanics are used to modify the sports equipments. For example, tee shirts, studs, spikes, swimming costumes, hockey sticks, different size footballs and low weight helmets for protection.

**iv. Improve in training techniques:** a teacher can analyse the player's movement or action with the help of the biomechanical principles. It helps in improving the training techniques.

**v. Prevents sports injuries:** it helps to find out the factors or the forces that can lead to the injuries during the game situation. It also helps in prevention of the sports injury.

**vi. Helps in understanding human body:** it gives the knowledge of different systems of our body. For example, nervous system, muscular system and skeletal system.

**vii. Knowledge of safety principles:** biomechanics gives the understanding to analyse different movements that can harm the player. The teachers remove those unnecessary and harmful movements.

**viii. Helps in research work:** biomechanics helps in teaching and learning process. It also helps the teacher to acquire precision and accuracy of movement.

**ix. Creates confidence in player:** The player knows that he is executing the movement scientifically with the help of principal of biomechanics. Thus the confidence of the player is enhanced.

**x. Helps in maintaining healthy body:** Principals of biomechanics gives deep knowledge about the effect of physical forces and movements over the body as well as the movements which are safe and promotes health. Thus biomechanics helps in maintaining healthy body.

**xi. Increases the popularity of sports:** biomechanical principles have brought remarkable improvements in respect of technique, equipment, skill and play fields. It helps in promoting the games and sports in the masses.