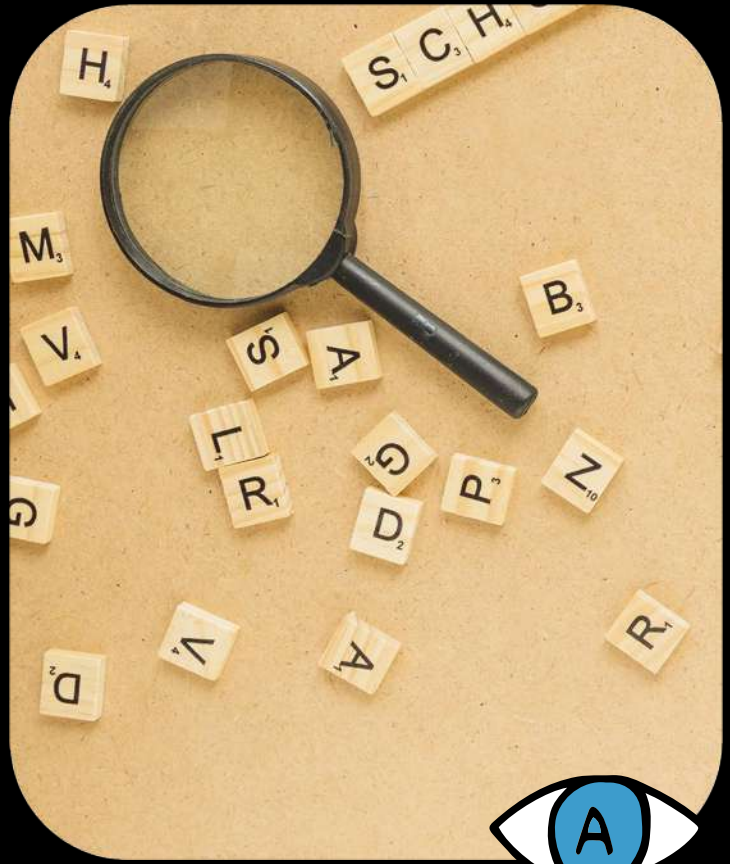
Unit -8

Physical Education



Unit – 8

Biomechanics and Sports

Unit Contents

8. **Centre of Gravity is the average location of an object's _____** [1]

(a) Weight
(b) Force
(c) Resistance
(d) Velocity

Ans. (a) Weight

Questions in CBSE Sample Paper 2022-23

Q3. Cartwheel in gymnastics is an example of _____

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

Questions in CBSE Sample Paper 2022-23

Q8. In Law of Acceleration, acceleration of an object is inversely proportionate to its

_____

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

Questions in CBSE Sample Paper 2022-23

Q37. Define Projectile and explain any two factors affecting projectile with help of examples from sports.

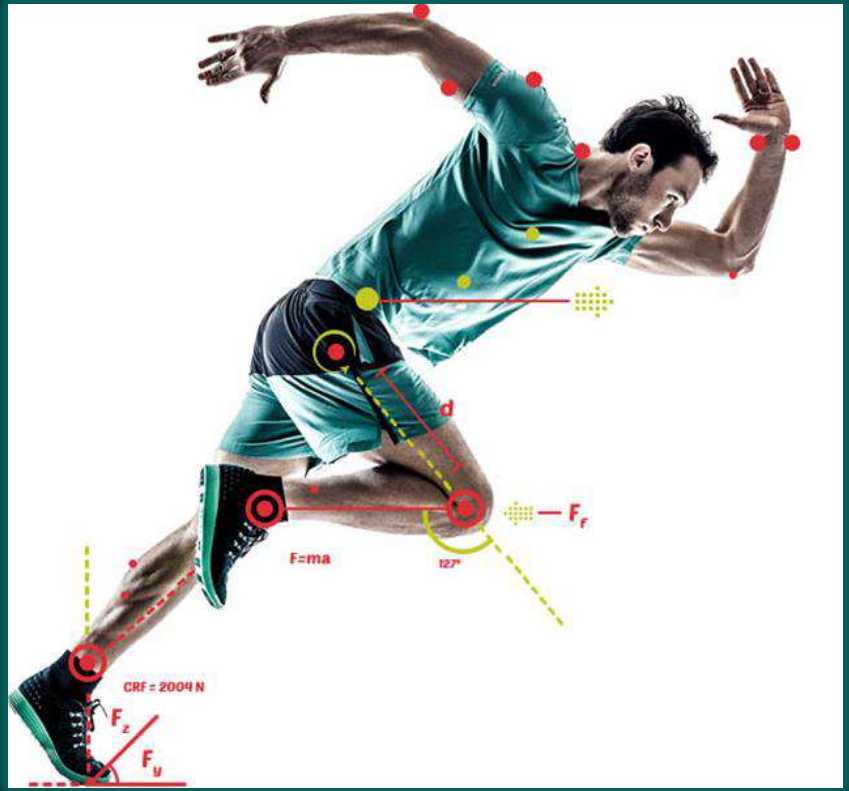
Meaning of Biomechanics

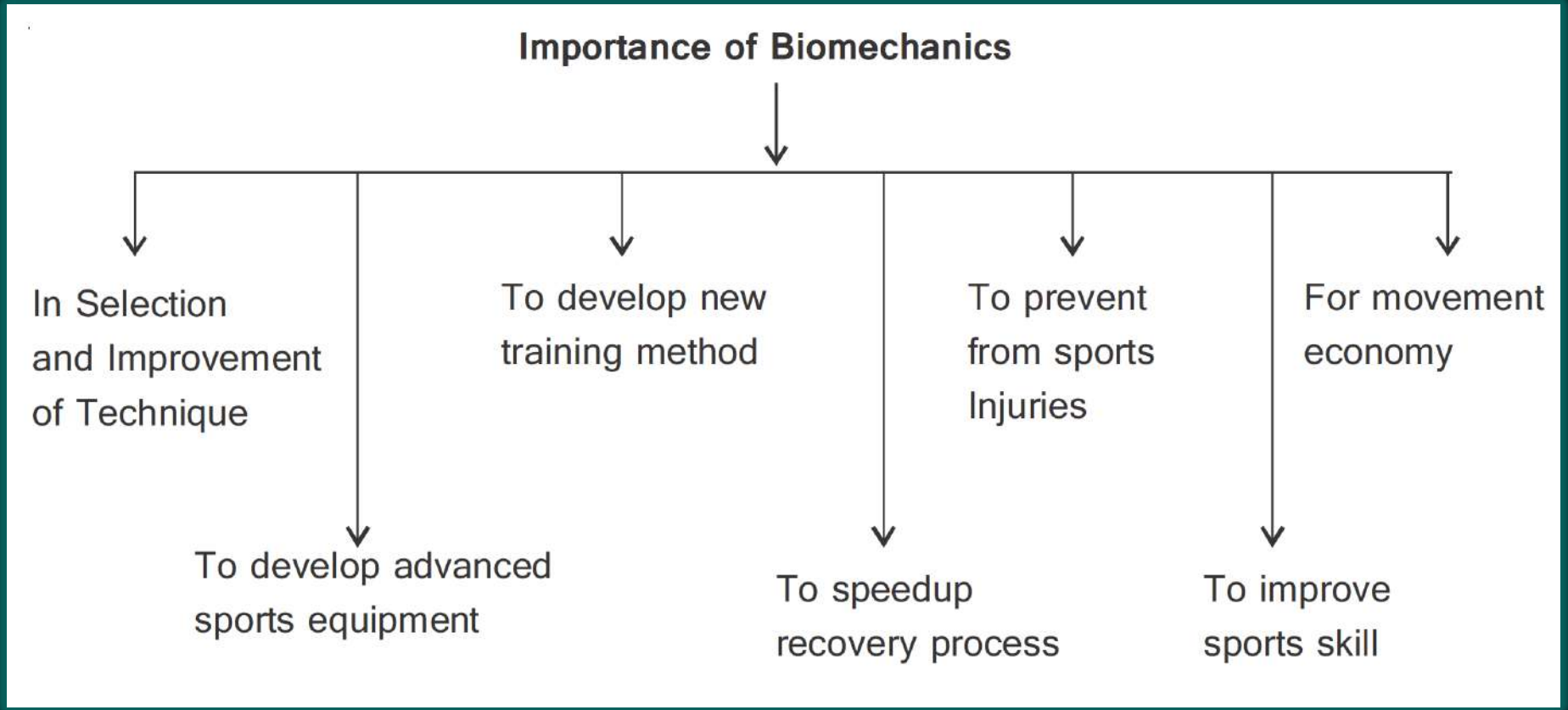
Meaning of Biomechanics :

Bio + Mechanics

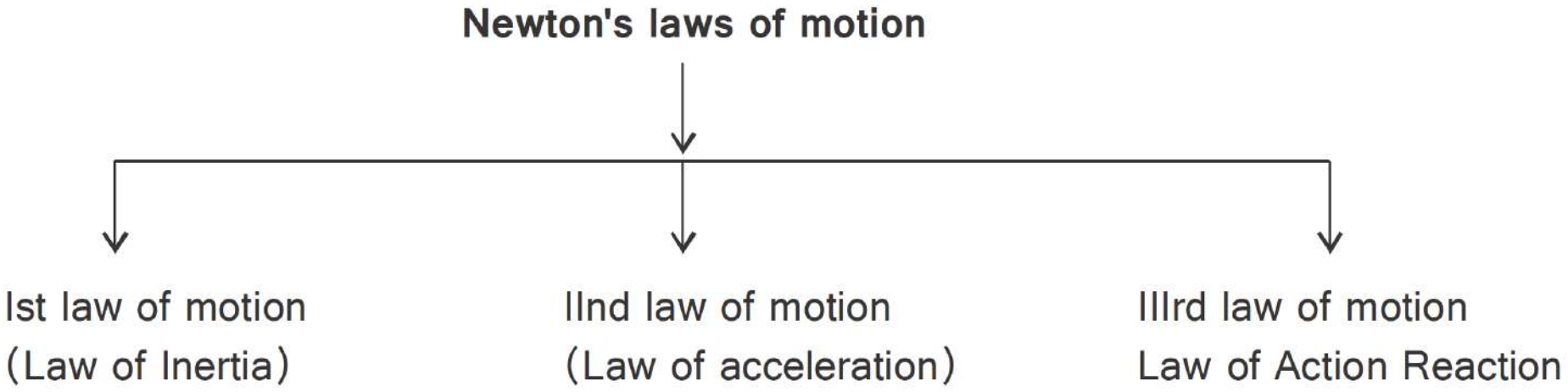
Bio = Living organism
Mechanics = Branch of Physical science which deals with force acting on a body in static condition or in moving condition.

Biomechanics : is the study of forces & their effects on human being is moving or in static condition.



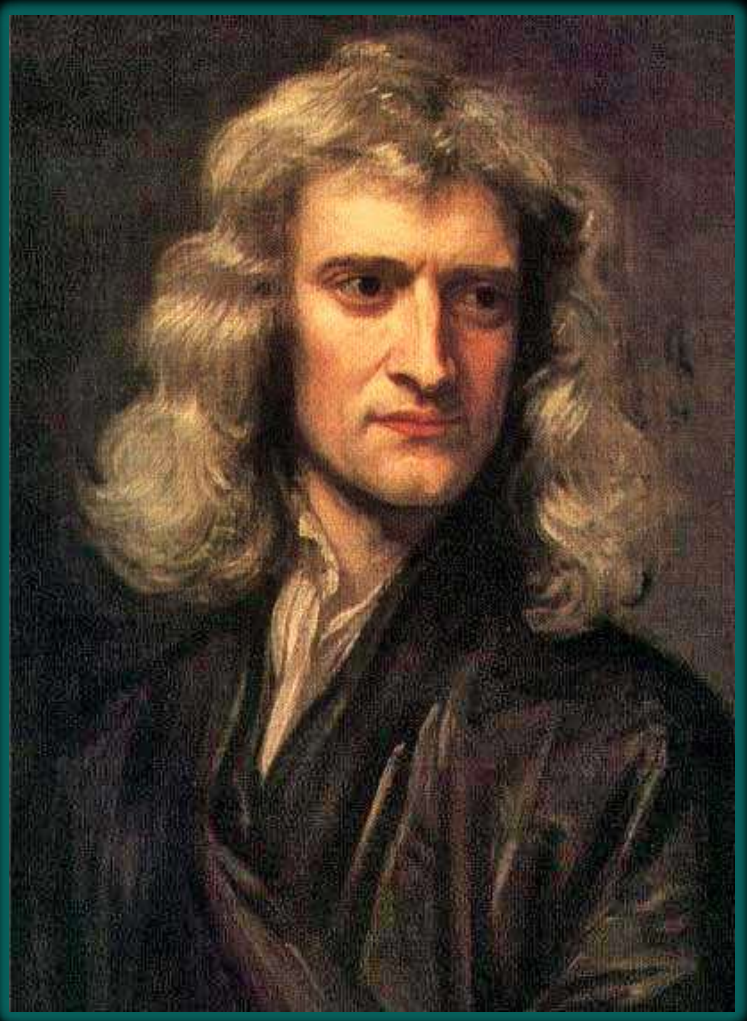

Importance of Biomechanics
In Selection and Improvement of Technique
To develop advanced sports equipment
To develop new training method
To speedup recovery process
To prevent from sports Injuries
To improve sports skill
For movement economy

8.1 Newton's Laws of motion and their application in sports :



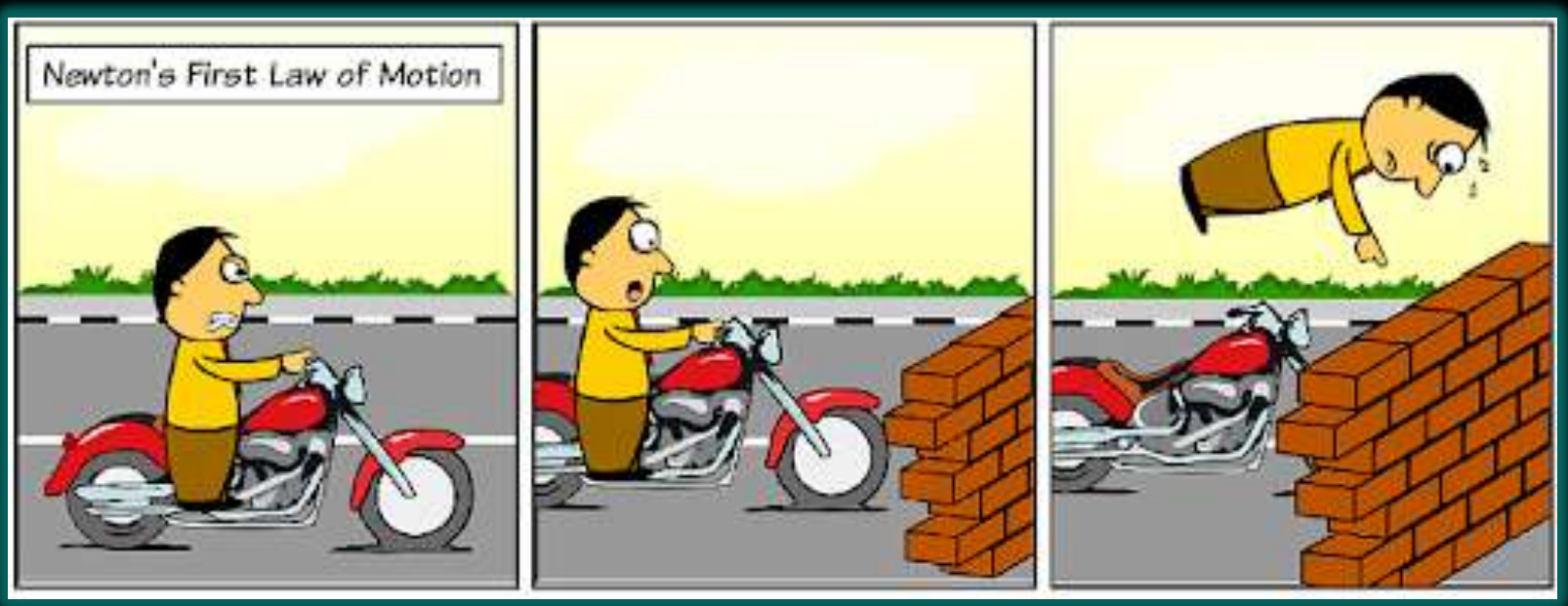
Sir Isaac Newton's three laws of motion describe the motion of massive bodies and how they interact.

Newton published his laws in 1687, in his seminal work "Principia Mathematica”



1st Law of Motion (Law of Inertia) :

Any object will be remains in its position until or unless any external force is applied on it.

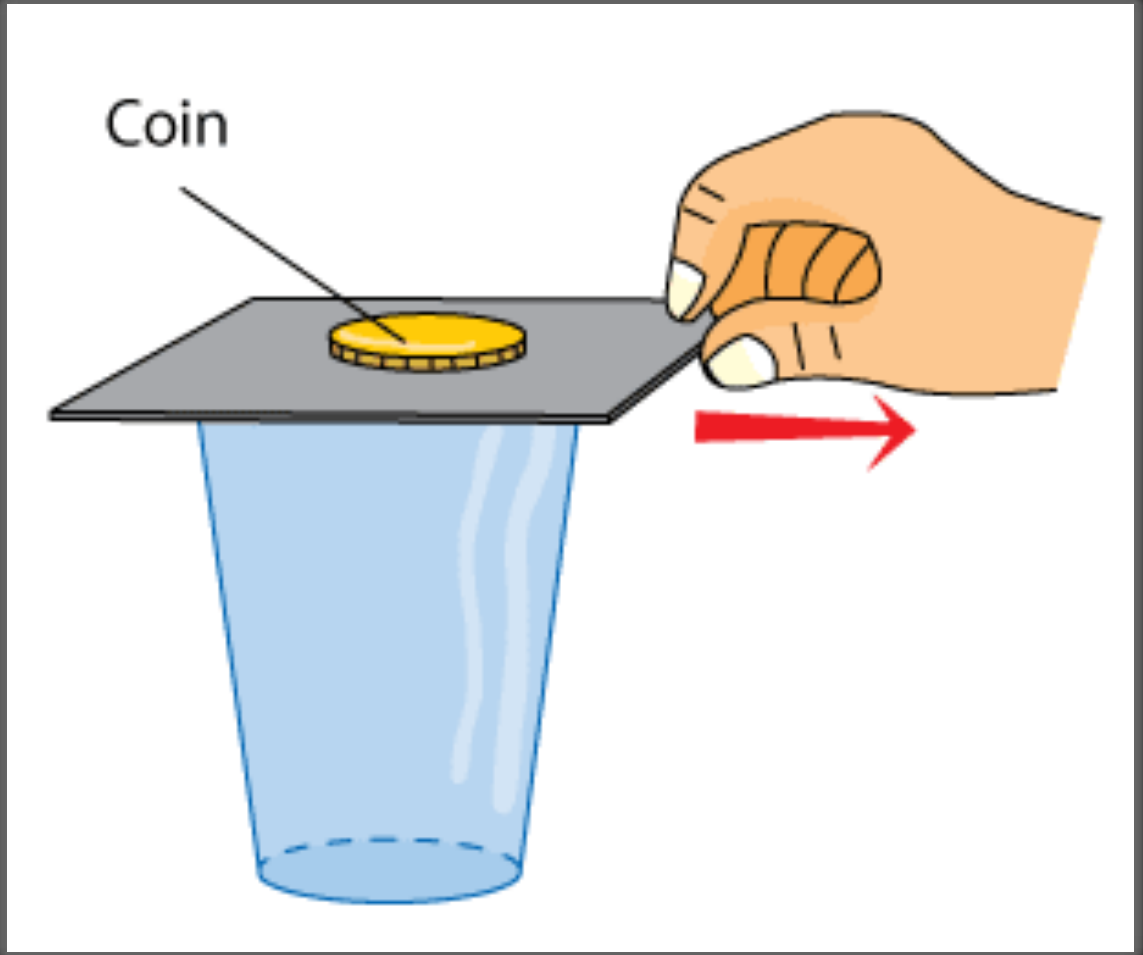


When a book is placed on a table , It remains stationary in position unless somebody acts to affect it and change its state .

When an object is pushed on the floor, It rolls for a certain distance , then slows down till it stops by the effect of frictional forces between the object and the floor that resist rolling (Friction is an external force that acts to change the object state) .

If these forces do not exist , the object would keep moving at a uniform velocity and would not stop .

Newton’s First Law is known as the **Law of Inertia** since the object can not change its state of rest or motion by itself .



Application of 1st Law in Sports :

1. A moving football slows down and then stops. It comes to rest due to the friction between ground and the ball.

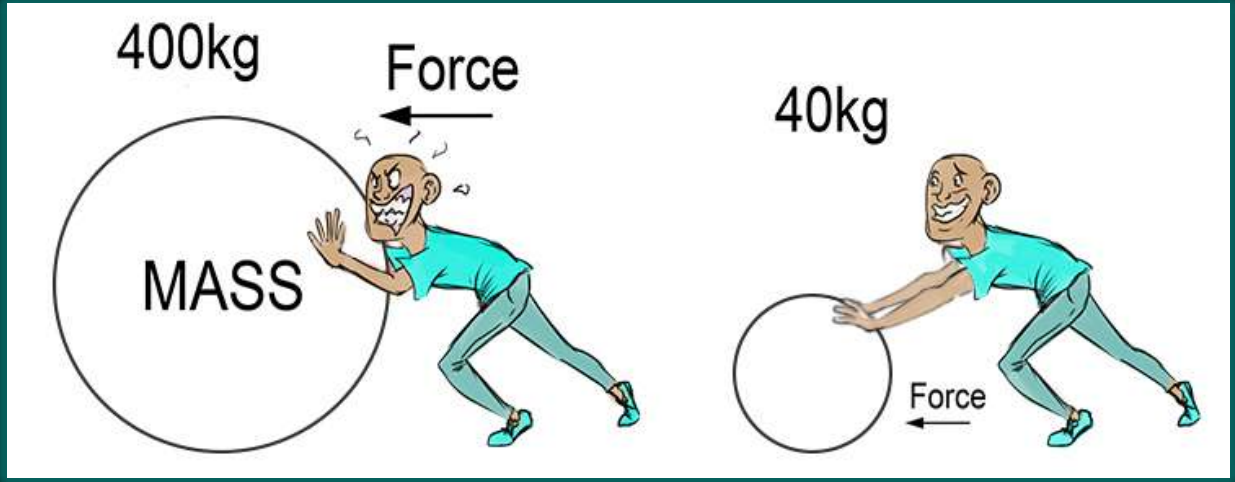
2. When a basketball is shot, it takes a parabolic path due to gravity acting on it. The basketball slows down because of air resistance.

2nd law of motion (Law of Acceleration) :

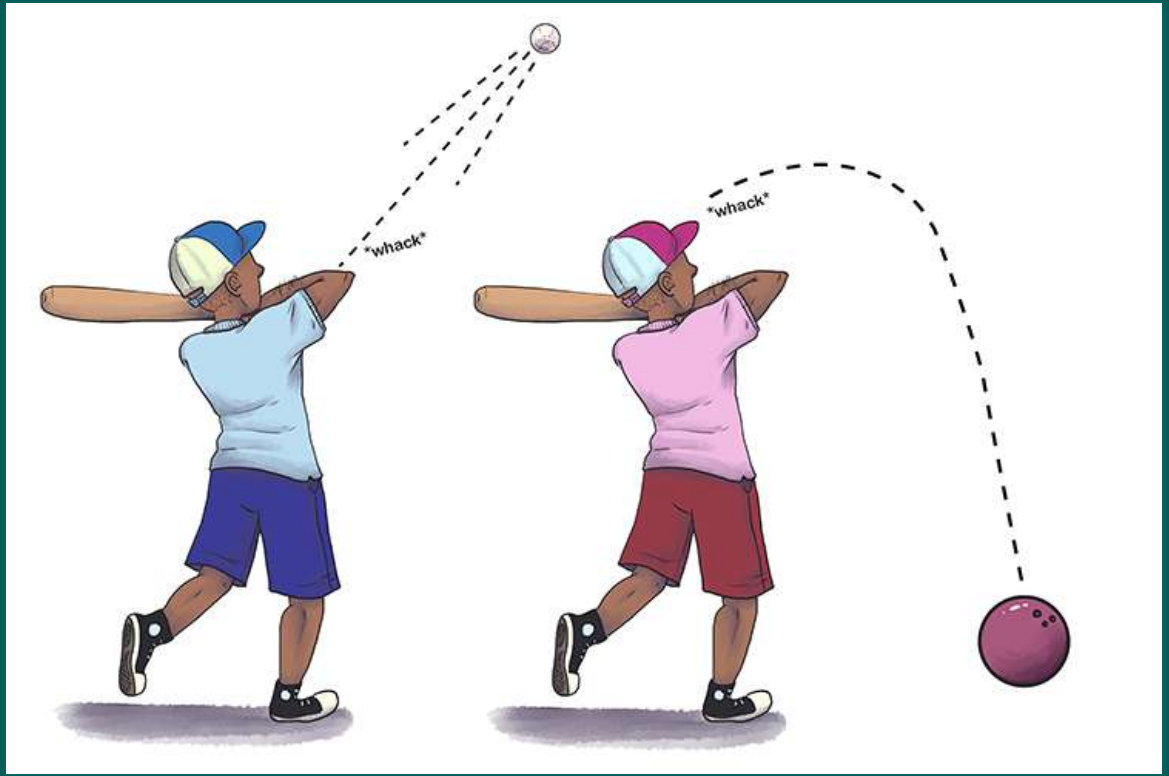
The rate of change of acceleration is directly proportional to the force applied on the object and Inversely proportional to the mass of the object.

F = ma

m = mass
a = acceleration



The second law shows that if you exert the same force on two objects of different mass, you will get different accelerations (changes in motion). The effect (acceleration) on the smaller mass will be greater (more noticeable).



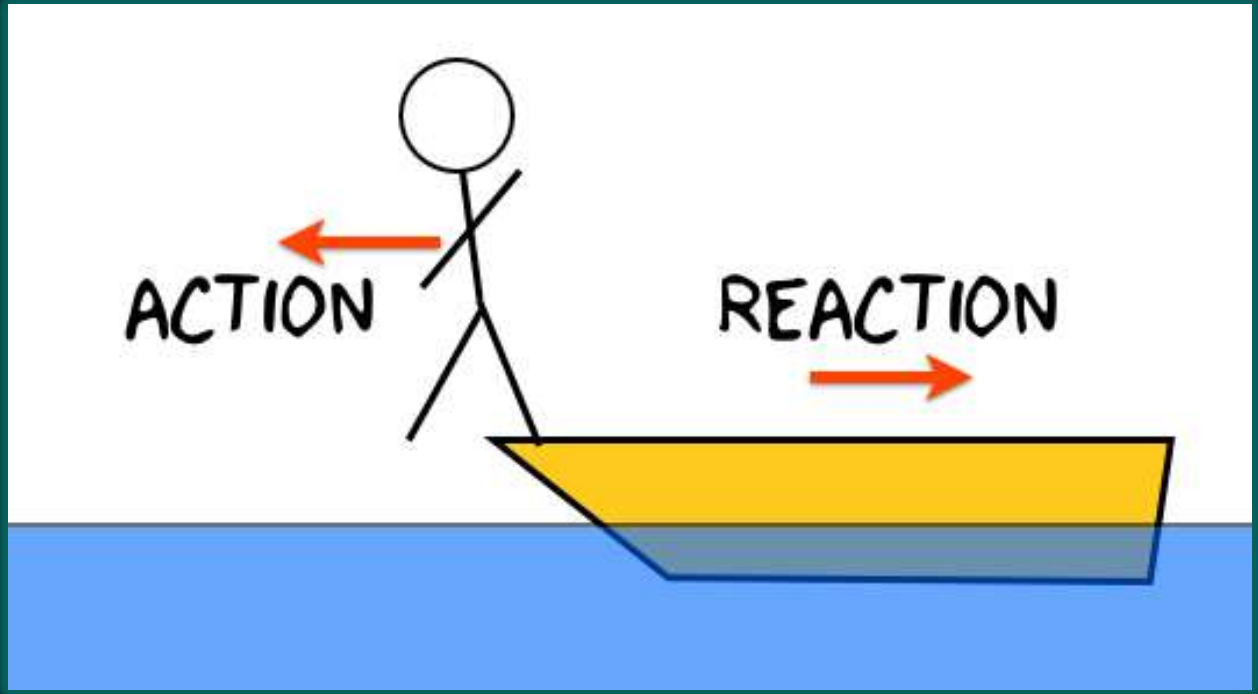
Application of 2nd Law in Sports :

1. If a baseball player hits a ball with double force, the rate at which the ball will accelerate will be doubled.

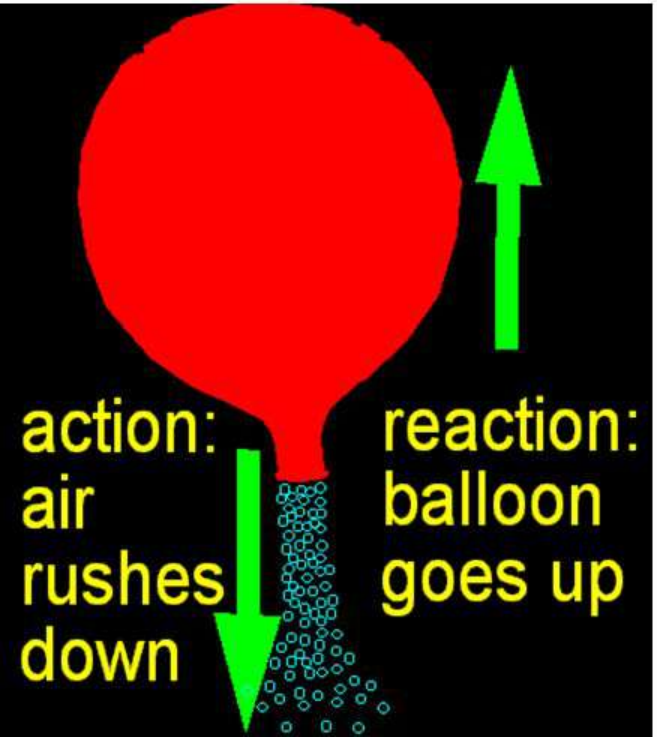
2. Hitting a ball with force in tennis.

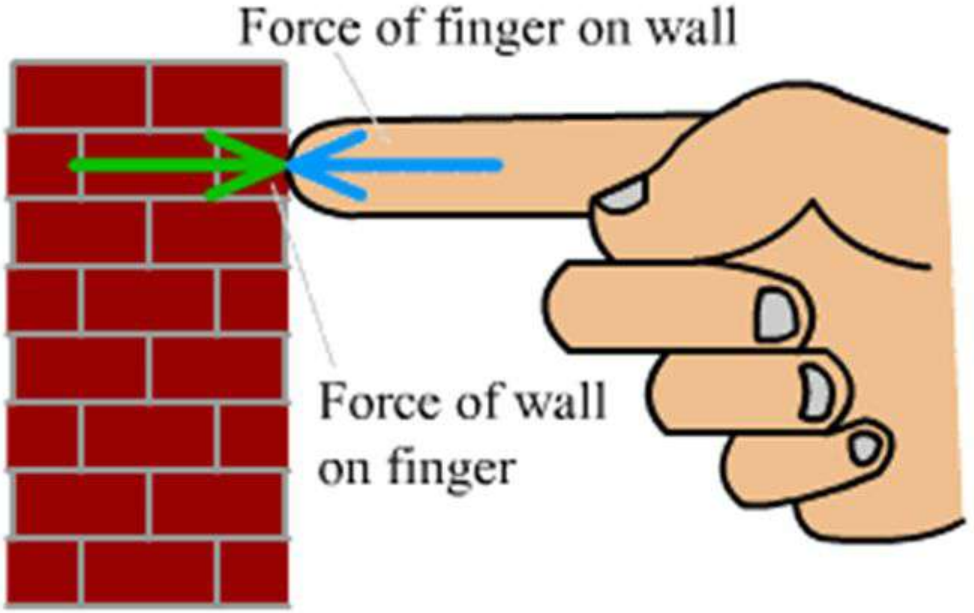
3rd law of motion (Law of action and Reaction) :

To Every action, There is equal & opposite reaction



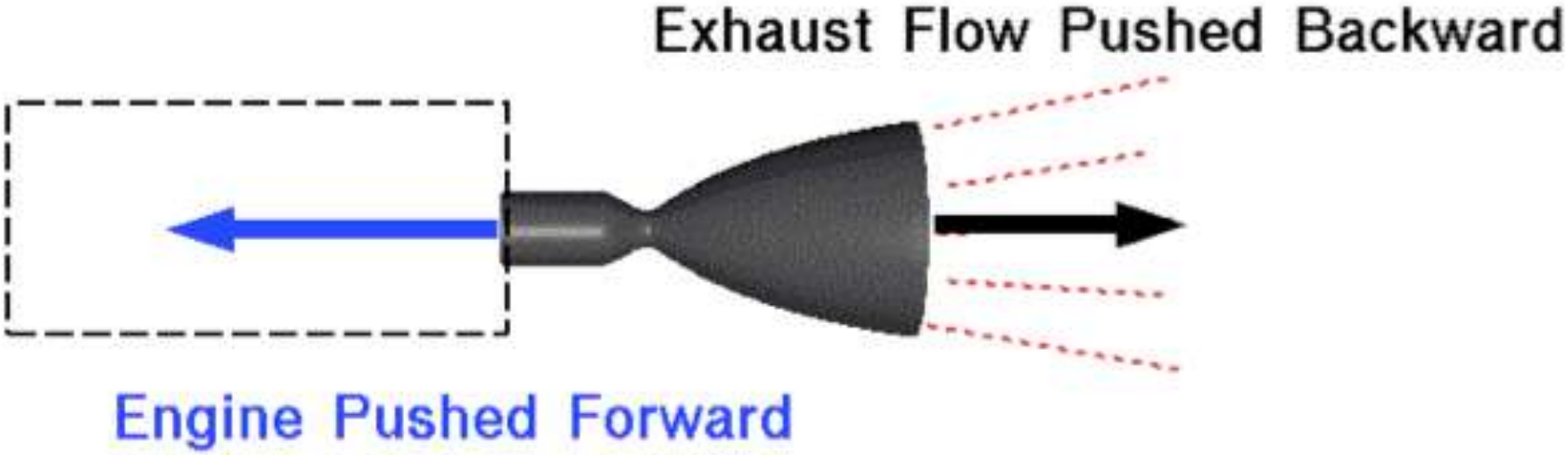
Newton's Third Law of Motion





- When one object exerts a force on a second object, the second exerts a force on the first that is equal in magnitude but opposite in direction.

Rocket Engine Thrust



For every action, there is an equal and opposite re-action.

Application of 3rd Law in Sports :

1. Swimming – Swimmer pushes water backwards and in turn water pushes swimmer forward.

2. Running – Runner pushes ground backwards and ground pushes the runner forward.

8.2 Types of Levers and their application in Sports

Levers in our body are formed from bones, joints and muscles.

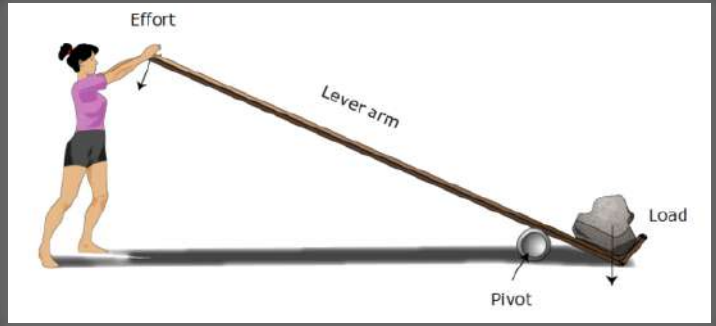
A lever consists of:

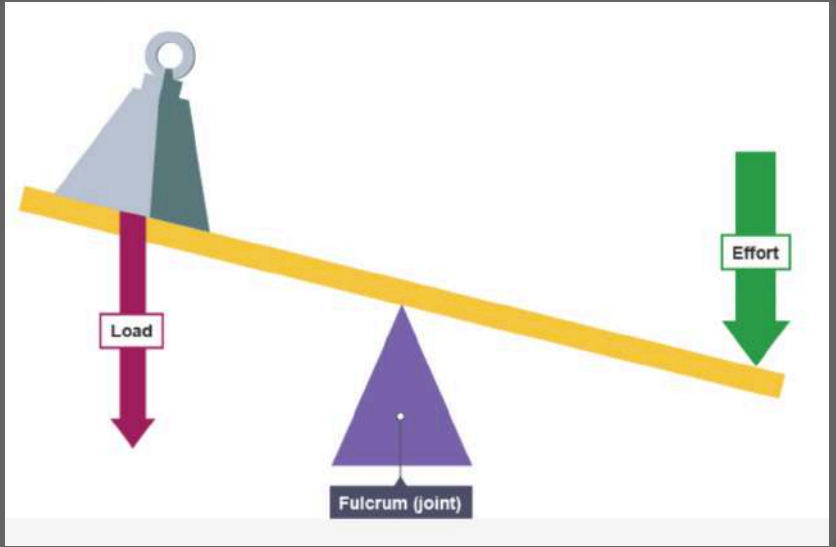
1. a rigid structure (bone)

2. a force acting upon it (muscle) to produce a turning movement (angular motion)

3. a fulcrum which is a fixed point (joint)

4. a load or resistance that is placed on the rigid structure (weight of body part being moved and anything that it is carrying)

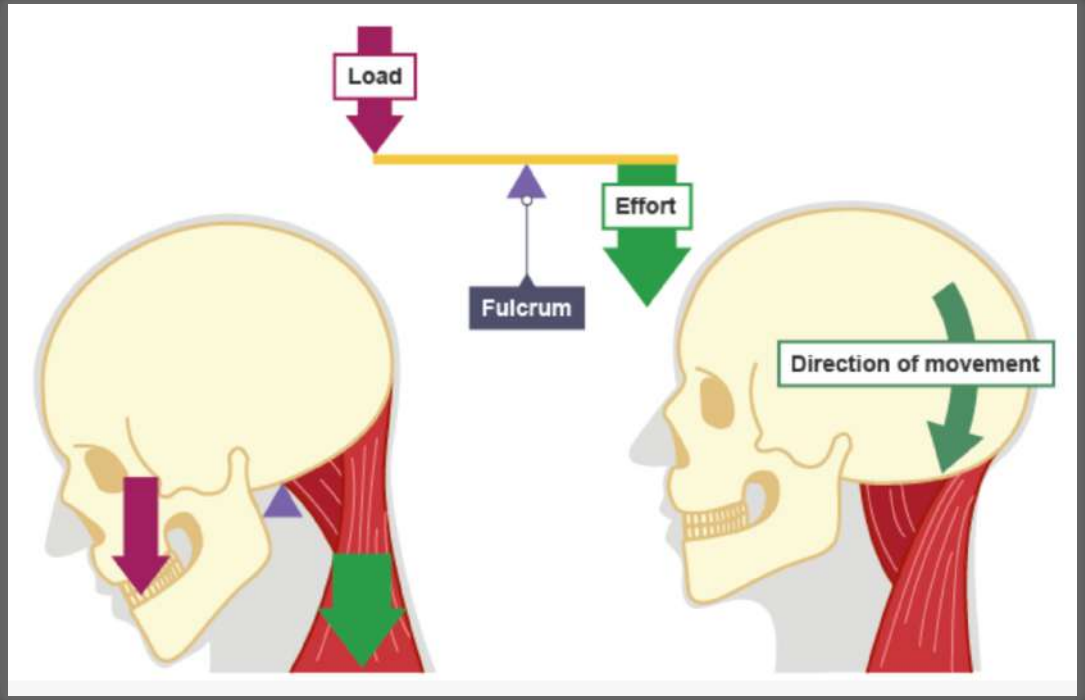




There are three types of lever.

1. First class lever – the fulcrum is in the middle of the effort and the load.

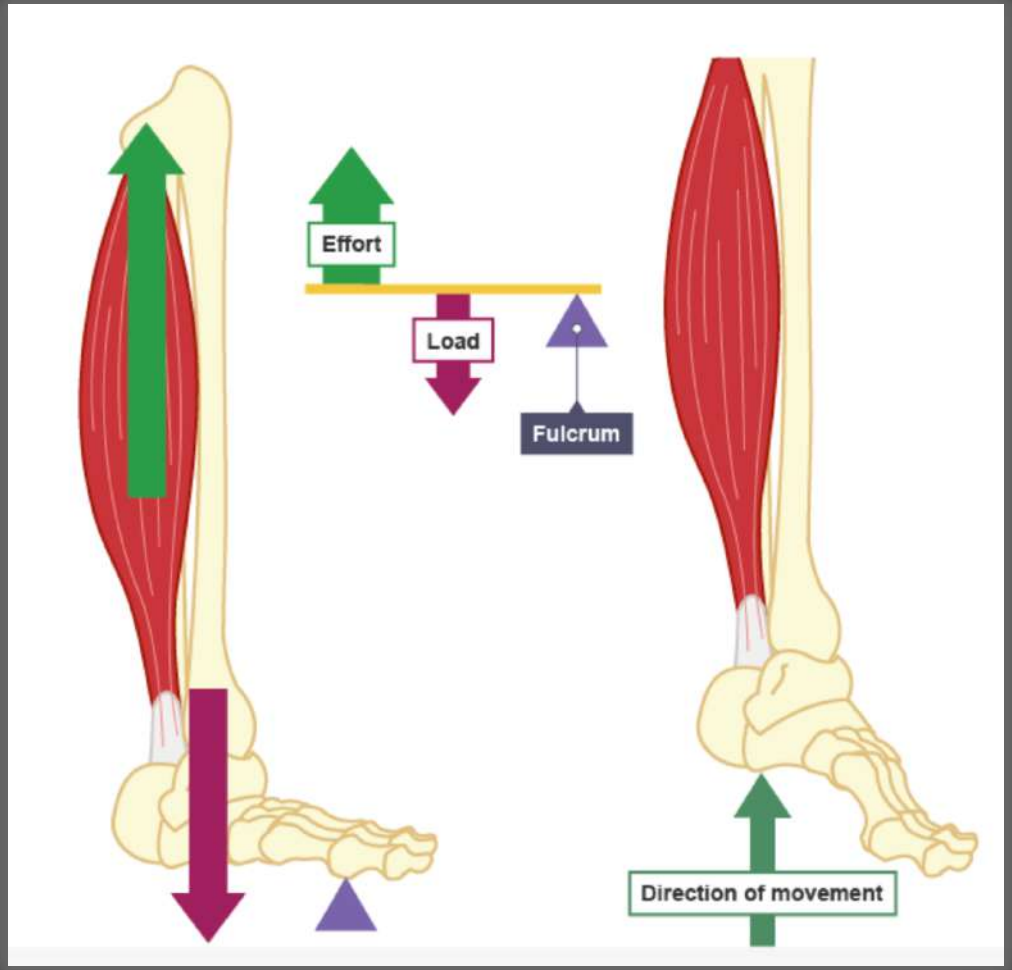
This type of lever is found in the neck when raising your head to head a football.
The neck muscles provide the effort, the neck is the fulcrum, and the weight of the head is the load.



2. Second class lever – the load is in the middle between the fulcrum and the effort.

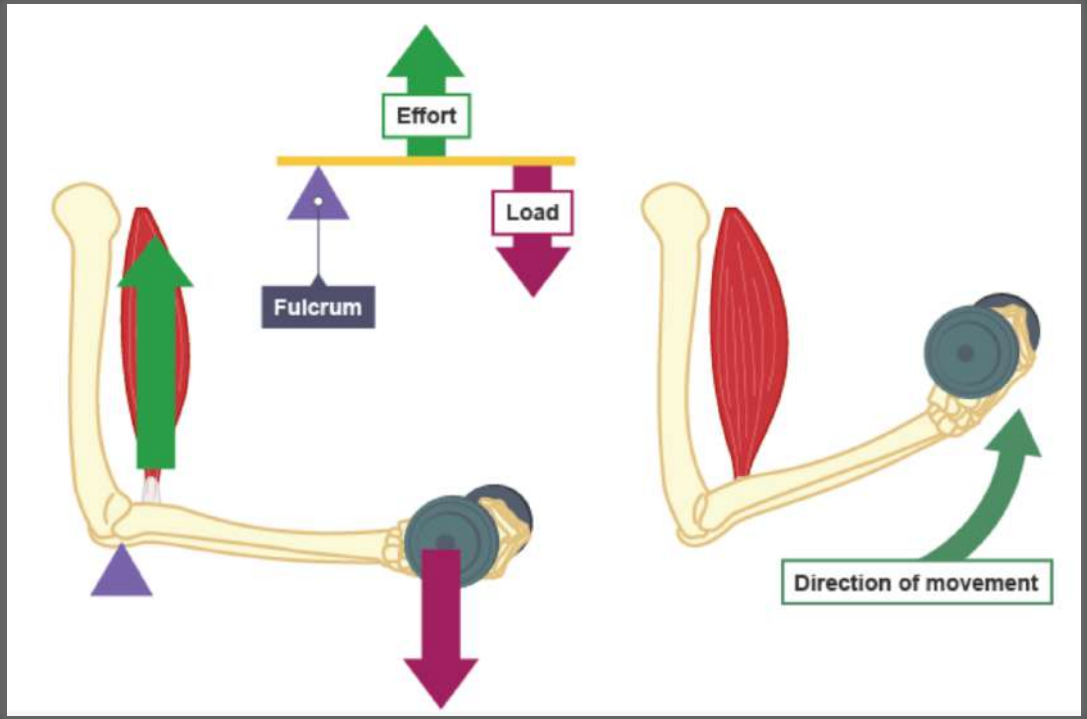
This type of lever is found in the ankle area. When standing on tiptoe, the ball of the foot acts as the fulcrum, the weight of the body acts as the load and the effort comes from the contraction of the gastrocnemius muscle.

This second class lever is used when taking off for a jump or pushing against the blocks in a sprint start.



3. Third class lever – the effort is in the middle between the fulcrum and the load.

During a biceps curl, the fulcrum is the elbow joint, the effort comes from the biceps contracting and the resistance is the weight of the forearm and any weight that it may be holding.

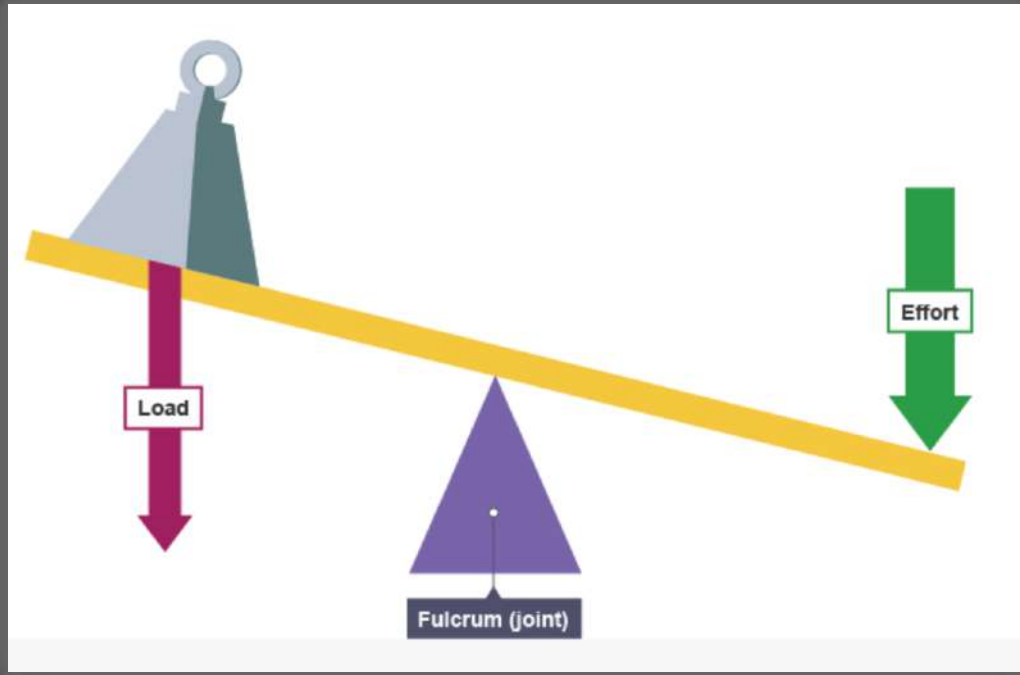


To recall the order of the levers use the term **'FLE'** - this will help you to remember which part of the lever is in the **middle**.

1st class lever - Fulcrum is in the middle.

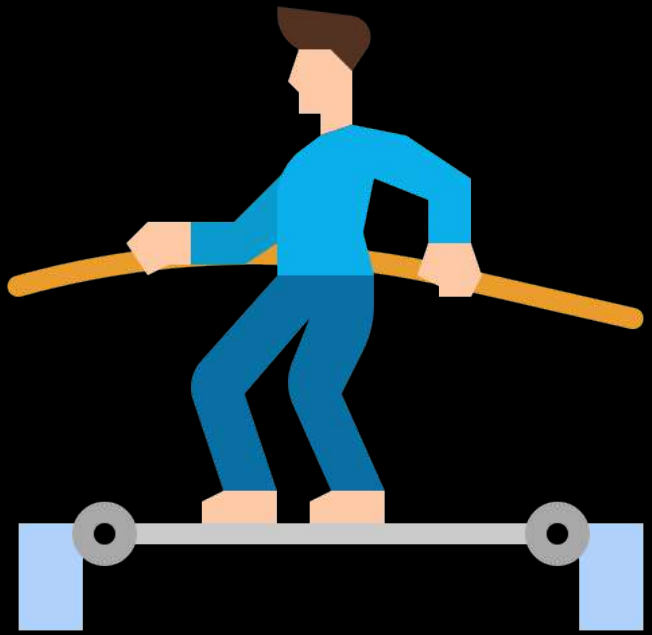
2nd class lever - Load is in the middle.

3rd class lever - Effort is in the middle.



8.3 Equilibrium : DYNAMIC AND STATIC & Center of Gravity AND ITS APPLICATION IN SPORTS :

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



Types of Equilibrium

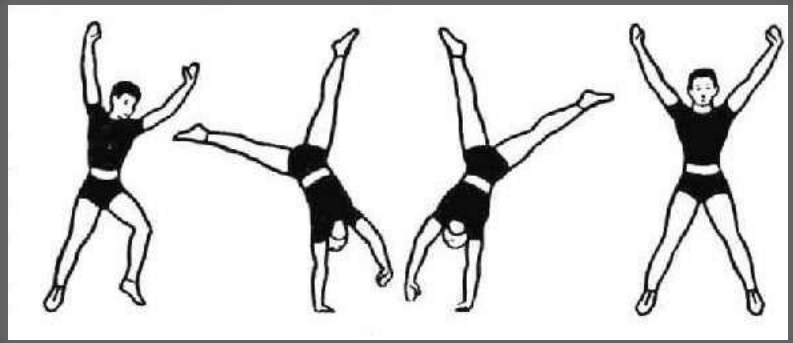
1. **Dynamic Equilibrium :** It is the balance of the body during movement.
2. **Static Equilibrium :** It is a balance of the body during its rest or stable position.

Dynamic Equilibrium :

When the body is in equilibrium but continues to move at an unknown speed.

For example,

1. A ball that moves at an unknown speed.
2. Cartwheel in gymnastics

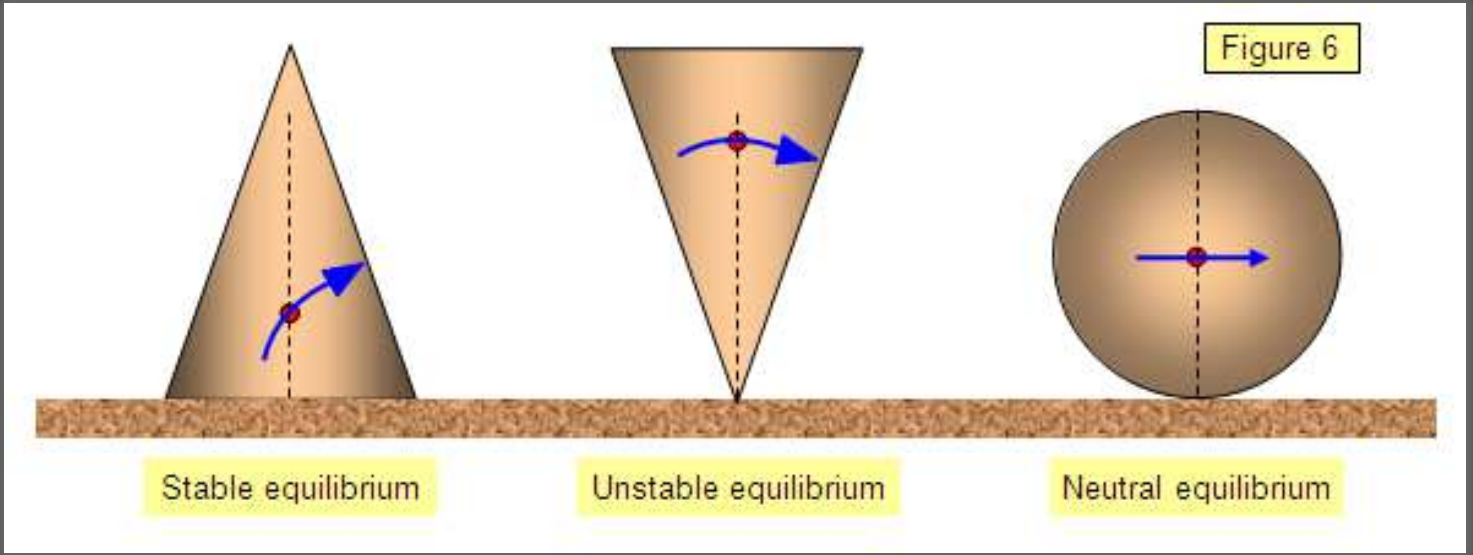


Static Equilibrium :

If the body is in equilibrium when it is stationary, it is called static equilibrium.

Principles to Determine THE DEGREE OF STABILITY :

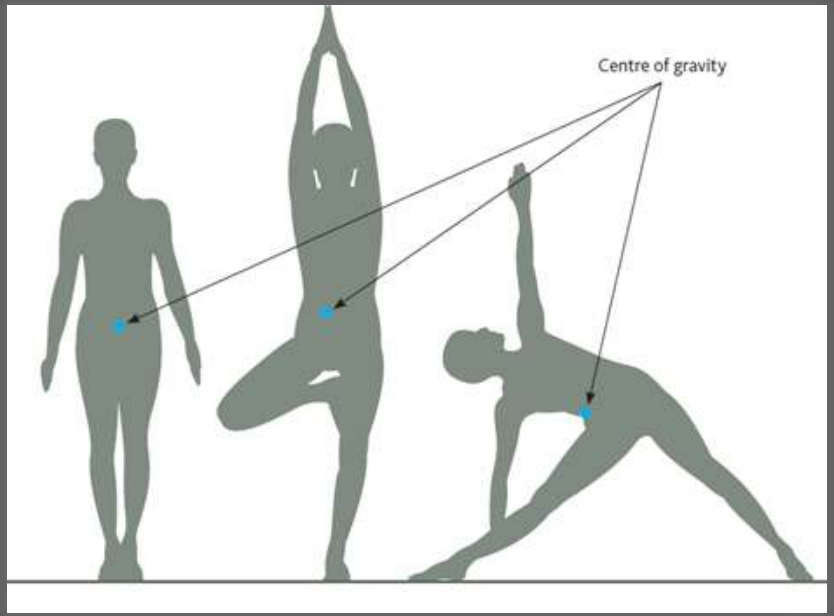
1. Broader the base, greater the stability.
2. Lower the center of gravity, higher the stability
3. Body weight is directly proportional to stability.



Centre of gravity :

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.

The center of gravity is fixed, provided the size and shape of the body do not change.



Application of Equilibrium

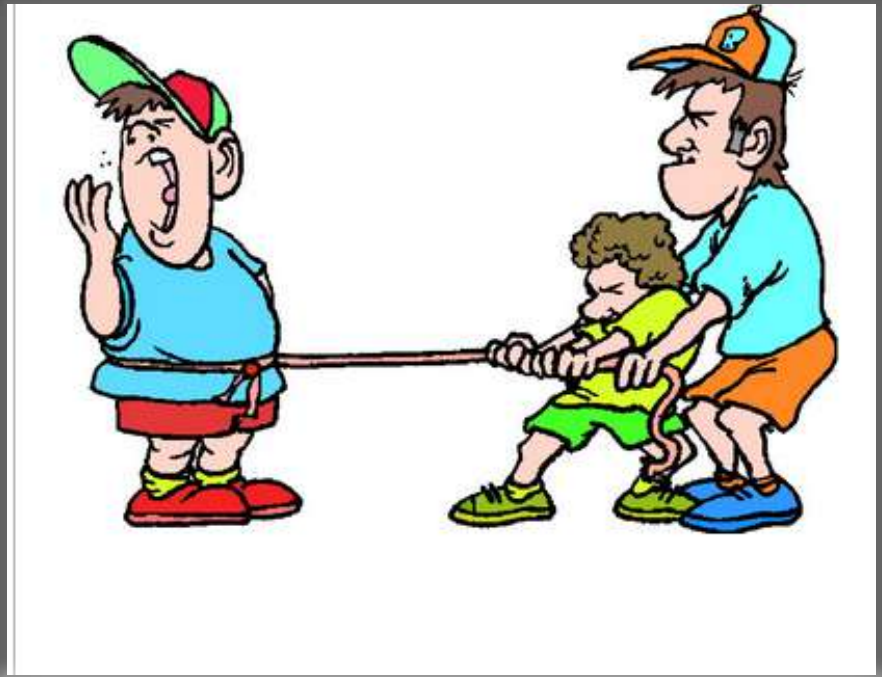
1. In the Starting Blocks, A SPRINTER ' S CENTER OF GRAVITY is ALIGNED along the rib cage and Forward knee,

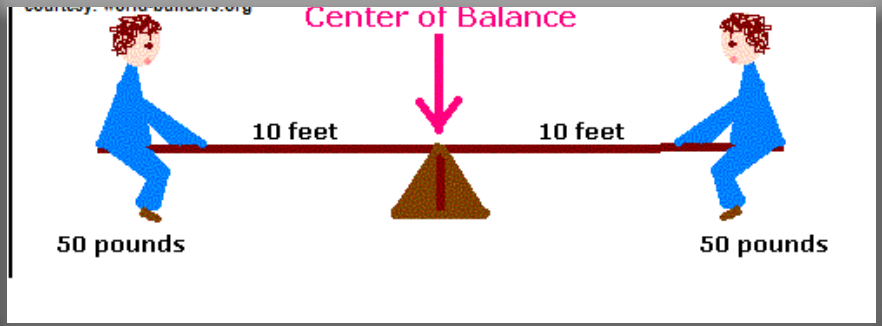
Thus maximizing the runner’s ability to shoot forward out of the blocks.

Application of Equilibrium

2. See-Saw

3. Tug of War





8.4 Friction & Sports

Friction is the force that opposes the motion of a solid object over another.

There are mainly four types of friction :

1. Static friction,
2. Sliding friction,
3. Rolling friction, and
4. Fluid friction.

1. Static Friction :

Static friction is defined as the frictional force that acts between the surfaces when they are at rest with respect to each other.

Static Friction Examples :

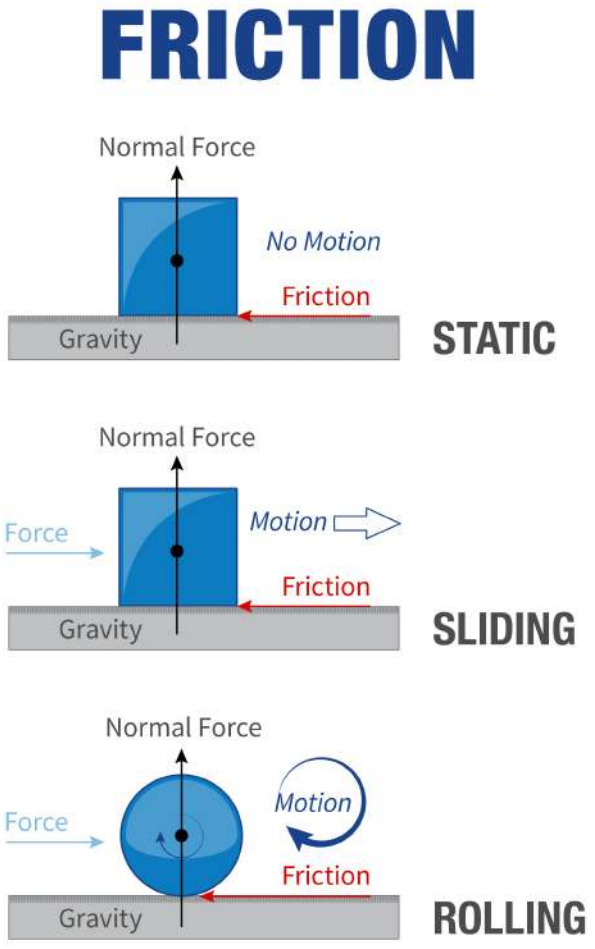
1. Skiing against the snow
2. Table lamp resting on the table

2. Sliding Friction :

Sliding friction is defined as the resistance that is created between any two objects when they are sliding against each other.

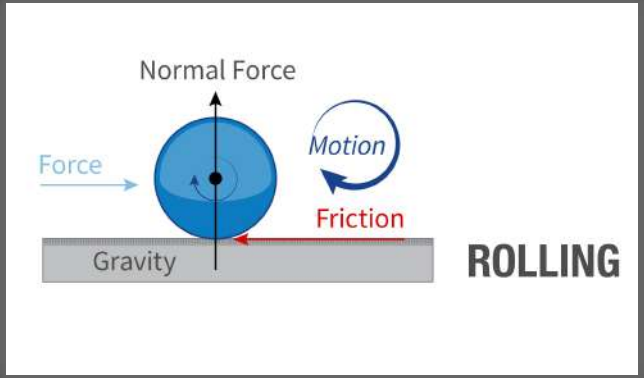
Examples Of Sliding Friction :

1. Sliding of the block across the floor
2. Two cards sliding against each other in a deck



3. Rolling Friction :

Rolling friction is defined as the force which resists the motion of a ball or wheel and is the weakest types of friction.

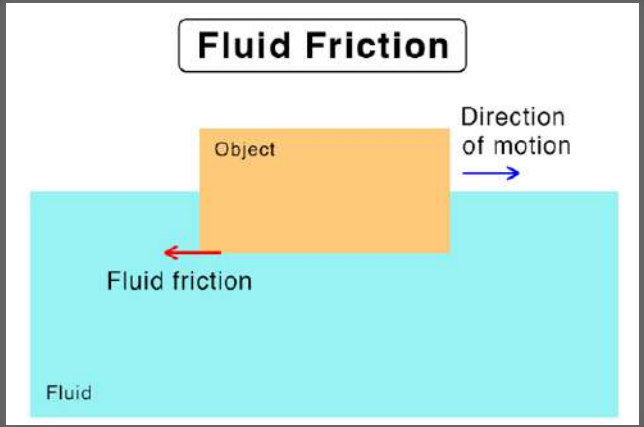


Examples Of Rolling Friction :

1. Rolling of the log on the ground
2. Wheels of the moving vehicles

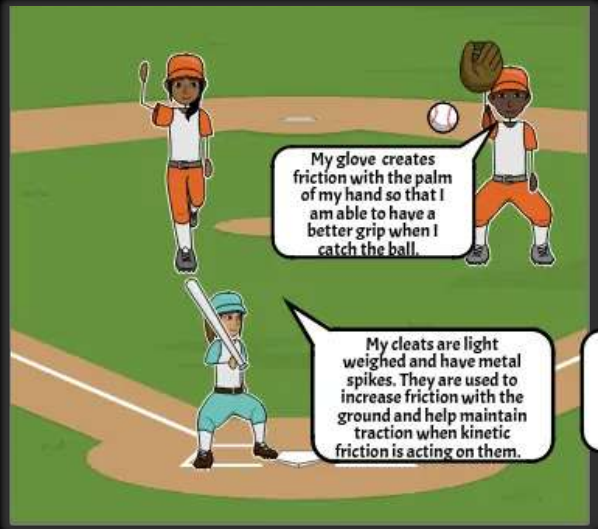
4. Fluid Friction :

Fluid friction is defined as the friction that exists between the layers of the fluid when they are moving relative to each other.

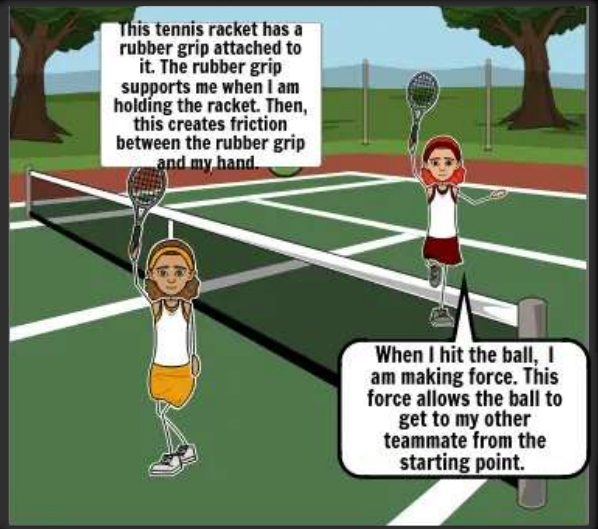


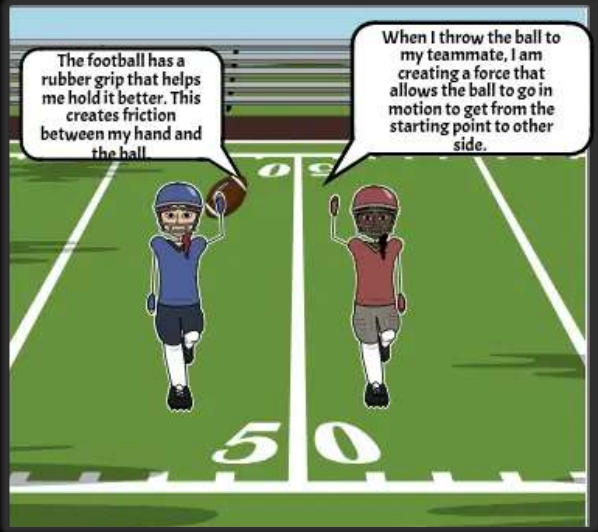
Examples Of Fluid Friction :

1. The flow of ink in pens
2. Swimming


My glove creates friction with the palm of my hand so that I am able to have a better grip when I catch the ball.
My cleats are light weighed and have metal spikes. They are used to increase friction with the ground and help maintain traction when kinetic friction is acting on them.


My cleats help me when I'm playing soccer because it creates a grip to the ground that lets me move easier and supports the lower body.
When I kick the ball, it creates force. This force allows the ball to go into motion. from the starting point to the goal.


This tennis racket has a rubber grip attached to it. The rubber grip supports me when I am holding the racket. Then, this creates friction between the rubber grip and my hand.
When I hit the ball, I am making force. This force allows the ball to get to my other teammate from the starting point.


The football has a rubber grip that helps me hold it better. This creates friction between my hand and the ball.
When I throw the ball to my teammate, I am creating a force that allows the ball to go in motion to get from the starting point to other side.
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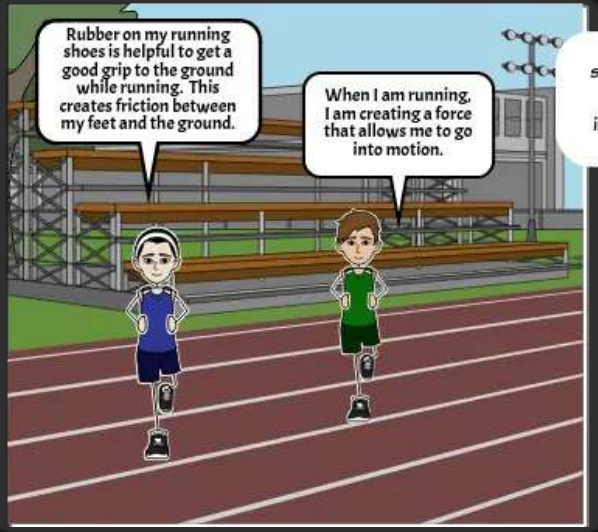

Rubber on my running shoes is helpful to get a good grip to the ground while running. This creates friction between my feet and the ground.
When I am running, I am creating a force that allows me to go into motion.

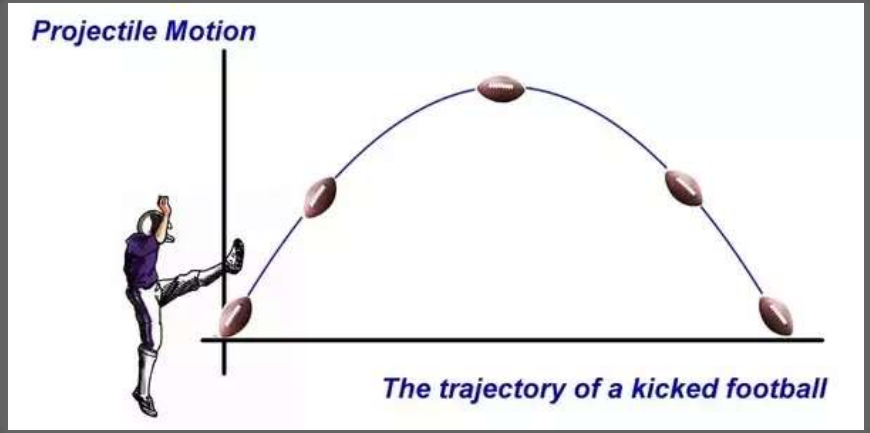

Basketball courts can be very slippery. When I use basketball shoes, I get a better grip to the floor as I am running for the ball. The rubber in my shoes creates friction with the ground to support me when I am moving.
When I throw the ball, I am creating a force to allow the ball to go into motion so that it can make it into the hoop.

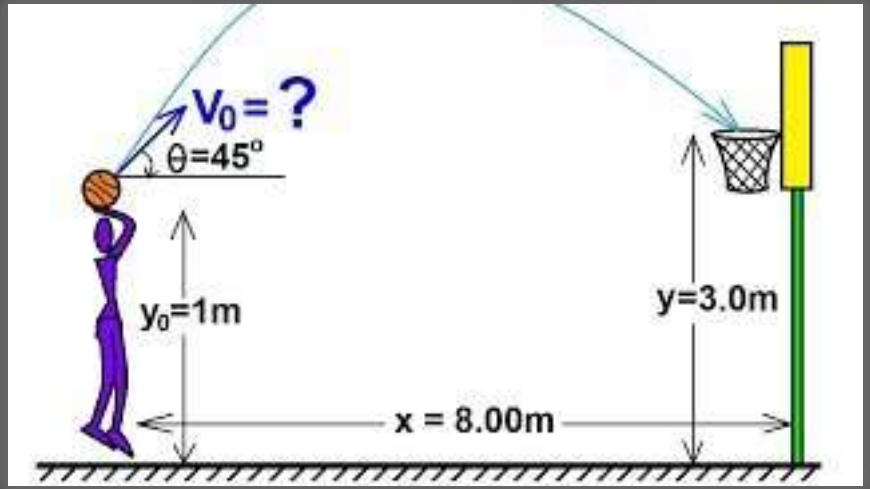
8.5 Projectile in Sports

What is Projectile?

A projectile is any object thrown into space upon which the only acting force is gravity. The primary force acting on a projectile is gravity. This doesn't necessarily mean that other forces do not act on it, just that their effect is minimal compared to gravity.

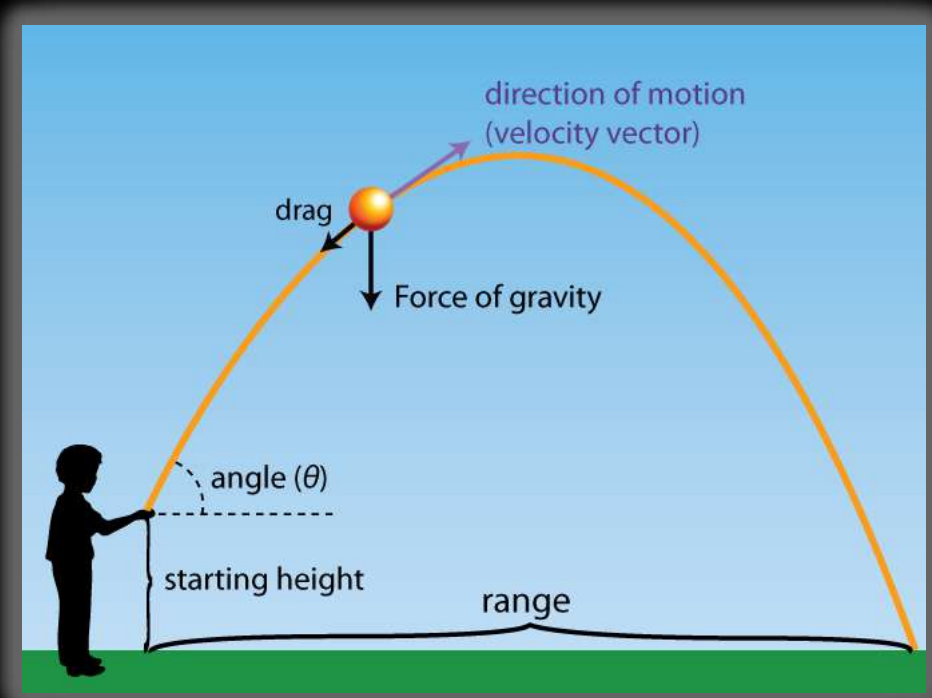
The path followed by a projectile is known as a trajectory.
A baseball batted or thrown is an example of the projectile.





Factors affecting the flight path of a Projectile are:

1. Gravity.
2. Air Resistance.
3. Speed of Release. (Initial Velocity)
4. Angle of Release
5. Height of Release



Maximum RANGE is Obtained at 45 Degree

Questions in CBSE Sample Paper 2022-23

Q3. Cartwheel in gymnastics is an example of _____

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

Questions in CBSE Sample Paper 2022-23

Q8. In Law of Acceleration, acceleration of an object is inversely proportionate to its

_____

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

Questions in CBSE Sample Paper 2022-23

Q37. Define Projectile and explain any two factors affecting projectile with help of examples from sports.

Q32. 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.

(4X1=4)

32.	a)	Third law of motion-Action reaction
	b)	1st picture
	c)	Law of Acceleration
	d)	Kinesiology
		Third law of motion-Action reaction

a) 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?
b) Among the above given pictures, Newton's 3rd law is depicted in_____
c) Newton's second law is also known as_____
d) The study of human body and various forces acting on it is_____

Questions in CBSE Sample Paper 2021

Q1. Acceleration of an object will increase as the net force increases depending on its

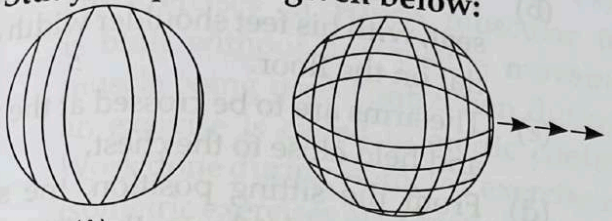
a. Density
b. Mass.
c. Shape
d. Volume

8. **Centre of Gravity is the average location of an object's _____** **[1]**

(a) Weight
(b) Force
(c) Resistance
(d) Velocity

Ans. (a) Weight

32. Study the pictures given below: [4]



(A) Stationary Ball

(B) Moving Ball

Based on your above study and your knowledge, answer the following questions:

(a) Which law of motion will be applied to initiate motion of the ball as depicted in the illustration (A) ?

(b) In illustration (B) which force is acting upon the ball to slow it down?

(c) Which law of motion will determine the quality of bounce?

(d) _____of an object directly depends upon the mass of the object and net force applied on it.

(a) Newton's first law of motion (Law of Inertia) will be applied to initiate motion of the ball as depicted in the illustration (A).

(b) Frictional or gravitational force is acting upon the ball to slow it down.

(c) Newton's third law of motion (Law of action and reaction) will determine the quality of bounce.

(d) A change in velocity (acceleration) of an object directly depends upon the mass of the object and net force applied on it.

MCQs

Q.1. Which is not the Importance of Biomechanics

a) Improvement of Technique
b) To understand the structure of Movement & effect of forces on the Movement
c) **To understand Physiology of human body.**
d) Improvement of sports Equipments

Q.2. Newton’s 2nd law is also known as

(a) Law of Action Reaction
(b) Law of Inertia
(c) Law of Acceleration.
(d) Law of velocity

Previous Year Questions

1. Bio-mechanics helps in which of the following? [2020]

A. In improving technique
B. in improving designs of sports equipment
C. in improving performance
D. All

2. Force of Friction depends upon? [2020]

A. Nature and surface of contact
B. Material of object in contact
C. both A and B
D. None