B. P. Ed. - CC-205

Kinesiology and Biomechanics

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Unit – I

Introduction to Kinesiology and Sports Biomechanics

o Meaning and Definition of Kinesiology and Sports Biomechanics
o Importance of Kinesiology and Sports Biomechanics to Physical Education Teacher, Athletes and Sports Coaches.
o Terminology of Fundamental Movements
o Fundamental concepts of following terms – Axes and Planes, Centre of Gravity, Equilibrium, Line of Gravity

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Unit – II

Fundamental Concept of Anatomy and Physiology

o Classification of Joints and Muscles
o Types of Muscle Contractions
o Posture – Meaning, Types and Importance of good posture.
o Fundamental concepts of following terms- Angle of Pull, All or None Law, Reciprocal Innovation

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Unit – III

Mechanical Concepts

o Force - Meaning, definition, types and its application to sports activities
o Lever - Meaning, definition, types and its application to human body.
o Newton's Laws of Motion – Meaning, definition and its application to sports activities.
o Projectile – Factors influencing projectile trajectory.

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Unit – IV

Kinematics and Kinetics of Human Movement

o Linear Kinematics – Distance and Displacement, speed and velocity, Acceleration
o Angular kinematics – Angular Distance and Displacement, Angular Speed and velocity, Angular Acceleration.
o Linear Kinetics – Inertia, Mass, Momentum, Friction.
o Angular Kinetics – Moment of inertia ,Couple, Stability.

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Question: 1- Define the meaning and importance of kinesiology in the field of sports.
Question: 2- Define the axis and plane and various types of movement in body parts around the axis and plane.
Question: 3- Describe the meaning and various kinds' joint movements are found in human body.
Question: 4- Shorts Notes

1. **Line of Gravity**
2. **Difference between isometric and isotonic contractions**
3. **Angle of Pull**
4. **Two joints muscles**

Question: 5- What is the meaning and types of muscles contraction

Question: 6- Describe the meaning of joints, their function and Classification of Joints.
Question: 7 - Describe the Anatomical terms of movement are used to describe the actions of muscles upon the skeleton
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Question: 1- Define the meaning and importance of kinesiology in the field of sports.
Meaning of kinesiology:

Aristotle is the known as the father of kinesiology.

The term kinesiology has been derived from the two words, “Kinesis” meaning “movement” and “Logia” meaning “study”. The meaning of term kinesiology is "the study of movement," The study of 'Movement' is called Kinesiology.

Kinesiology is the scientific study of human or non-human body movement. Kinesiology is the study of human body movements and muscle function. All the movements of animals and human beings are studied in this field of science called kinesiology.

Kinesiology is the academic discipline of kinesiology comprises the sub-disciplines of exercise physiology, biomechanics, sport and exercise psychology, athletic training and sports medicine, sports administration, physical education, and fitness and health promotion.

Definition of kinesiology:

- The study of the principles of mechanics and anatomy in relation to human movement.
- Kinesiology is defined as “the assessment of human movement and performance and its rehabilitation and management to maintain, rehabilitate or enhance movement and performance.”

On the above definition we can say that Kinesiology is the study of human movement, function and performance and its effect on human health. It deals specifically with the mechanics of movement.

Importance of kinesiology in physical education and sports

Today kinesiology is applicable to a number of fields in our economy. Some of the applications include physical education, rehabilitation, health promotion, health and safety, workplaces, sports and exercise.

- To provide the future physical education teacher/coaches with the knowledge necessary for analyzing human motion.
- To assist in the learning and improvement of motor skills via the application of analysis of motion.
- With the applied anatomic background the knowledge of kinesiology helps to prevent injuries.
- Economy of the movement can be ensured.
- Effectiveness of the movement can be ensured.
- For clinical/rehabilitation purposes kinesiology has great importance.
- Designing and teaching of exercise/conditioning /fundamental movements the knowledge of kinesiology is must.
- Self-realization about own performance is best realized by the athlete themselves with the background of kinesiology.
- To discover and recognize the underlying principles of movement
- It is an educational experience for physical education and physical medicine.
- Effective teaching of motor skills with knowledge of kinesiology are best achieved in regards to a. Fundamental motor skills b. Specialized motor skills

- Evaluation of exercise and activity from the point of view of their effect on the human structure.
- For physiotherapy, physical medicine purposes.
- For postural analysis, and corrective physical education.
- To provide the future physical education teacher/coaches with the knowledge necessary for analyzing human motion. Analysis specific to musculoskeletal system involved in the motion.
- To assist in the learning and improvement of motor skills via the application of analysis of motion. Using the findings of analysis to formulate the ideal technique of the motor action which assists in learning it and also in comparison to improve it.
- With the applied anatomic background the knowledge of kinesiology helps to prevent injuries.
- Economy of the movement can be ensured. As, inefficiencies and unnecessary movements are removed from the movement.
- Effectiveness of the movement can be ensured.
- For clinical/rehabilitation purposes kinesiology has great importance.
- Designing and teaching of exercise/conditioning /fundamental movements the knowledge of kinesiology is must.
- For physiotherapy, physical medicine purposes.
- For postural analysis, and corrective physical education
- Kinesiology also helps in focusing the exact muscle one is trying to exercise for the better.
- The Kinesiology therapy helps to boost the self-confidence of a person.
- It helps to maintain the mental and emotional balance of a person.

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Question: 2 - Define the axis and plane and various types of movement in body parts around the axis and plane.

Axis and Planes:

Axis and planes of the body is an imaginary concept. In medical science, it's important to study human anatomy and joint movement. The body performs movements through a plane and around an axis.

Axis:-

An axis is a straight line around which an object rotates or an axis is an imaginary line about which the body (or limb) rotates. Movements at the joints of human musco-skeletal system are mainly rotational and take place about a line perpendicular to the plane in which they occur. This line is known as axis of rotation. It can be divided in three parts

1. **Frontal Horizontal Axis -**Axis of the body that passes horizontally from side to side/ left to right at right angles to the sagittal plane. It is formed by the intersection of frontal and horizontal plane.
2. **Vertical Axis** - The vertical axis passes vertically from inferior to superior. It passes straight through the top of the head down between feet. It is formed by the intersection of sagittal and frontal plane. It is also known as longitudinal axis. It is the longest axis.
3. **Sagittal Horizontal Axis** -This axis passes horizontally from posterior to anterior. It is formed by the intersection of the sagittal and transverse plane. Sagittal axis passes from front to back.

Plane:

Plane is an imaginary, flat surface passing through the body organ on which the movement occurs. There are following types of planes:

1. **Sagittal or Medial plane:** The sagittal plane is a vertical plane passing from the rear to the front, dividing the body into left and right halves. It is also known as anteroposterior plane.
   Most of the sports and exercise movements that are two dimensional, such as running, long jumping and somersault take place in this plane.
2. **Transverse or Horizontal plane: -** The transverse plane divides the body into top and bottom halves. In fact, it divides the body into upper and lower sections. This plane lays horizontally that why it is also called horizontal plane.
   Movements along this plane can include an ice-skating spin or rotation to play a tennis shot.
3. **Frontal or Coronal plane:** Frontal plane is perpendicular to the ground. The frontal plane is also vertical and passes from left to right dividing the body into posterior to anterior halves. It is also known as coronal plane. Frontal plane cuts the body into front and back.
   Movements along the frontal plane can include cartwheel and star jumps.

Types of Movements

Physical activity is made possible by movements and motions. Every movement takes place, in one plane and around one axis. There are various types of movement in body parts which can be divided in four types i.e. gliding & angular movements, circumduction & rotation and few other movements.

Gliding movements:

Gliding movements is the simplest kind of movement that can take place in a joint, one surface gliding or moving over another without any angular or rotator movement.

Angular movement:

Angular movement occurs between long bones. By angular movement the angle between the two bones increased or decreased. The various movements which fall under angular movements are described below:

Flexion:

Bending parts at a joint so that the angle between them decreases and parts come closer together (bending the lower limb at the knee).

Extensions:

Straightening parts, so that the angle between them increases and parts moves farther apart (straightening the lower limb at the knee).

Abduction

Abduction means moving a part away from the midline (lifting the upper limb horizontally to form a right angle with the side of the body))

Adduction

Adduction means moving a part towards the midline (returning the upper limb from the horizontal position to the side of the body).

Circumduction:

Circumduction is that movement which takes place between the head of a bone and its articular cavity. This kind of motion is best seen in the shoulder and hip joints.

Rotation:

Rotation is a form of movement in which a bone moves around a central axis without undergoing any displacement from the axis. Moving a part around an axis is called rotation. Example: Twisting the head side to side.

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Question: 3- Describe the meaning and various kinds' joint movements are found in human body.

Joint Movements

Joint movement is also known as Anatomical Movements. **Anatomical terms of movement** are used to describe the actions of muscles upon the skeleton. Muscles contract to produce movement at joints, and the subsequent movements can be precisely described using this terminology.

Kinds of Joint Movements

There are three kinds of Joint Movements:

1. Angular Movements
2. Rotation Movements
3. Special Movements

<u>Angular movements</u>

In of Angular movements there is Increase or Decrease in the angle b/w articulating bones.

Types of Angular movements;- I. Flexion II. Extension III. Hyperextension IV. Abduction V. Adduction VI. Circumduction VII. Lateral Flexion

Flexion

- Decreasing angle b/w articulation bones.
- Takes body forward from anatomical position.
- Allowed in: 1. Ball and socket Joint 2. Condyloid joint 3. Hinge joint 4. Pivot joint 5. Saddle joint

<u>Extension</u>

- Increase in angle b/w articulation bones.
- Takes body backward from anatomical position.
- Allowed in: 1. Ball and socket Joint 2. Condyloid joint 3. Hinge joint 4. Pivot joint 5. Saddle joint

Hyper Extension

- Increase angle b/w articulation bones beyond the normal ROM.
- Takes body further backward from anatomical position.
- Allowed in: 1. Ball and socket Joint 2. Condyloid joint 3. Pivot joint 4. Saddle joint

Abduction

- Takes body part away from the midline of the body.
- Joints permit these: 1. Ball and socket 2. Condyloid joint 3. Saddle joint

Adduction

- Takes body part towards the midline of the body.
- Joints permit these: 1. Ball and socket 2. Condyloid joint 3. Saddle joint

Circumduction

- Circumduction combination is of two joint movements; Flexion, extension, abduction, adduction.
- Allowed at;

1. Ball and socket joint
2. Condyloid joint
3. Saddle joint

Lateral Flexion

• Body part is taken away from median plane by bending.
• Only possible at; Trunk and Neck joint.
• "Side Bending"

Rotation Movement

• In rotational movement where something revolves around a single long axis.
• Three kinds of rotation:
1. Medial/Internal Rotation
2. Lateral Rotation
3. Left/right rotation.

Medial Rotation

• Internal rotation
• Takes part of body inwards.
• At shoulder and hip joint.

Lateral Rotation

• External Rotation
• Takes body part outwards.
• At shoulder and hip joint.

Left and Right rotation

• At Trunk and Neck joint.
• Reference point: Front of chest or neck.

Special Movements occurs at certain joints:

Only occurs at certain joints. • Cannot be classified as angular and rotational. • Movements are as follows: i. Elevation ii. Depression iii. Protraction iv. Retraction v. Eversion vi. Inversion vii. Dorsiflexion viii. Plantar flexion ix. Pronation x. Supination

• **Elevation -**Upward movement of structure
Example: Shrugging your shoulder; elevation of scapula.
• **Depression**- Downward movement of structure of the body.
Example: Depression of shoulder joint.
• **Protraction -** Movement of structure in the anterior direction.
Example: Crossing of arms; protraction of clavicle.
• **Retraction -** Movement of structure in the posterior direction.
Example: - Uncrossing of arms; retraction of clavicle.
• **Eversion -** Movement wherein plantar surface faces away from midline.
Example: Foot eversion.
• **Inversion -** Movement wherein plantar surface faces towards the midline.
Example: Foot inversion
• **Dorsiflexion**- Dorsum= upper surface; superior surface. Bending at the ankle where toe lifted toward the knee.
Example: Ankle dorsiflexion.
• **Plantar flexion-** Bending at ankle when heel is lifted.
Example: Ankle plantar-flexion.
• **Pronation**-A kind of rotational movement of radius and ulna where forearm where in palm faces down.
Example: Pronation of forearm.
• **Supination** -A kind of rotational movement of radius and ulna where forearm where in palm faces up.

Example: Supination of forearm

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Question: 4- Short Notes

- **Line of Gravity**
- **Difference between isometric and isotonic contractions**
- **Angle of Pull**
- **Two joints muscles**
- **Various kinds of skeletal joints in human body according to their mobility, giving one example for each.**
- **Diarthrosis type joint**
- **Law of Reciprocal Proportion**

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Line of Gravity:-

Line of gravity is an imaginary line that extends from the center of gravity to the base of support.

In the anatomical position the line of gravity is between the both legs and feet right under the person. The location of this line in relation to the base of support has a huge influence on balance and stability's. The line of gravity and is always perpendicular to the ground.

The line of gravity is an imaginary vertical line passing from the centre of gravity to the ground or surface the object or person is on. It is the direction that gravity is acting upon the person or object.

- When the line of gravity is within the base of support, an object or person is said to be stable.
- When the line of gravity falls outside the base of support, the object or person is said to be unstable.

The line of gravity is an imaginary vertical line from the centre of gravity to the ground or surface the object or person is on. It is the direction that gravity is acting upon the person or object. In the image above you can see the line of gravity in red going down to the ground from the centre of gravity, indicating the force of gravity upon the sprinter.

The closer the line of gravity is to the centre of the base of support (your next dash point) the better balanced a person is in this position. If the line of gravity fall outside of the base of support the person must provide corrective muscle action, usually movement otherwise they will fall. This is why the sprinter's line of gravity is in front of his base of support (back foot on the ground) because it must be there in order for him to be stable and move forwards. If the line is in his base of support and he starts running, he will fall backward, unless he moves the line to in front of him.

Since a lower center of gravity means better balance and stability, a shorter line of gravity between the center of gravity and the ground also means better balance and stability. So rugby player dodging through the defense will shift her line of gravity outside of her base of support in various directions as she changes direction and will also lower her centre of gravity.

Difference between isometric and isotonic contractions

While isotonic and isometric contractions form essential parts of the muscular contraction system, there are however major differences between them.

S. No.	Isometric Contractions	Isotonic Contractions

1	In an isometric contraction, the muscle remains the same length as the tension changes.	In an isotonic contraction, the muscles maintain the same tension as it shortens.
2	Isometric contractions have longer contraction and relaxation times.	Isotonic contractions are known to have shorter contraction and relaxation times
3	Changes in temperature affect each kind of contraction differently. it however decreases the time taken for an isometric contraction	Changes in temperature affect each kind of contraction differently. While an increase in temperature increases the time taken for shortening of muscles during an isotonic contraction.
4	Isometric contractions release less heat, making this a more energy efficient form of contraction.	Isotonic contractions release a great deal of heat during muscle contraction making this less energy efficient
5	Isometric contractions occur at the beginning and end.	In addition, isotonic contractions occur in the middle of a contraction
6	Isometric contractions occur when there is no change in the length of the contracting muscle.	In an **isotonic contraction** is one in which the muscle maintains the same tension as it shortens.
7	"Isometric" means "same length," and in contractions of this variety, the muscle does not shorten and its tension never exceeds the opposing force.	The word "isotonic is derived from two greek word: "iso" meaning same and" tenikos" meaning tension. In an isotonic contraction is one in which the muscles will maintain the same tension as it contracts or shortens
8	During isometric contraction, no shortening occurs and, therefore, no external work is done	During isotonic contraction, shortening occurs and external work is done.
9	During the muscle contractions, isometric phase increases when load increases	Whereas isotonic phase decreases when load increases.

● Angle of Pull

The term "angle of pull" was originally created and used by medical professionals.

The angle formed between the line of pull of a muscle and the longitudinal axis of the bone in which the muscle is acting. The line of pull is usually indicated by the joint angle. It affects the strength of muscle action; at only certain angles of pull can a muscle exert maximal tension. Variable resistance exercise machines compensate for variations in muscular tension at different joint angles. Weight lifters and body builders use this term frequently when they are describing a specific technique.

The angle of pull is used to describe the angle of any muscle and the bone to which it's attached.

Definitions of Angle of Pull:

Angle between muscle insertion and bone on which it inserts.

Angle of pull of a muscle is an important concept in therapeutic exercise. If you want to produce the maximal torque from a muscle, the joint must be positioned so that the muscle being worked has a 90° angle of pull on the extremity. This concept also works for external forces applied to the body. With pulleys, the maximal resistance occurs when the angle of pull of the pulley's rope is 90° to the extremity being resisted, as shown in figure 3.14. With free weights,

the maximal resistance occurs when the pull of the weight is perpendicular to the ground regardless of the extremity's position; in this position the line of pull of the weight (relative to the earth) is 90°. For example, when a supine patient performs elbow flexion with a weight, the greatest resistance is at the start of the motion when the patient's elbow moves from full extension to flexion. If the patient is standing or sitting, however, the maximal resistance from the weight is when the elbow is at 90°. The clinician must realize how changes in position alter resistance arm lengths. The clinician should always know when in the range of motion maximum resistance occurs.

Orthopedists use this term when they are describing a person's range of motion. When orthopedists consider a patient's limited mobility, they use angle of pull to determine the percentage of muscle disability. Physical therapists use this to measure a patient's rehabilitation progress over time.

Two Joints Muscles:

The study in which **muscles** at which **joints,** cause what kinds of movement are the refer of **kinesiology**. Movement happens in the body at **joints.**

A **joint** is where two bones come together. When one or more **muscles** contract and this results in changing the angle between two bones at a **joint**, then movement has occurred.

Meaning of two joint muscles:

A two-joint muscle (or bi- articular) is one that crosses two joints.

A bi-articular muscle is one that crosses two joints. There are, in the legs, three primary muscles that fit the definition bi-articular. They are the rectus femoris at the front of the thighs, the biceps femoris or hamstrings at the back of the thighs, and the gastrocnemius, or calf muscles.

Two Joint Muscles are muscles that cross two joints of the body and therefore perform more than one joint function. For example, the Rectus Femoris (considered one of the quads) actually **crosses** both the hip and knee joints and performs hip flexion and knee extension. It both lifts and straightens your leg.

All major joints of the body - the shoulders, elbows, hips, knees, and ankles - are governed by at least one two joints muscle.

Example:-

Rectus femoris as a two-joint hip flexor because it crosses both the hip and knee joint. However, the rectus femoris is not alone in this function. The sartorius and gracilis cross both the hip and knee joints as well.

Various kinds of skeletal joints in human body according to their mobility, giving one example for each.

On the basis of mobility, joints are classified into three main groups:

1. Fibrous joint:

These do not allow any movement because the bones are firmly fixed together by strong collagen fibres. Example: skull and tooth joint.

2. Cartilaginous joint:

The two bones are joined together with the help of a disc or pad of white fibrous cartilage. Example: sternum, ribs, vertebral column, etc.

3. Synovial joint:

These are freely movable joints which allow movement in one or more directions. The bones are covered by a membrane called synovial membrane and cavity is filled with synovial fluid.

These are further of various types:

A. Ball and socket joint in the shoulder and hip joint.
B. Hinge joint in elbow and knee joint.
C. Pivot joint in radius and ulna below the elbow.
D. Gliding joint in wrist and tassels.
E. Saddle joint in carpels and metacarpals of a human thumb.
F. The condyloid joint in fingers.

Diarthrosis type joint

A freely mobile joint is classified as a **diarthrosis** (plural = diarthroses). This functional classification of joints describes all synovial joints of the body, which provide the majority of body movements.

Most diarthrotic joints are found in the appendicular skeleton and give the limbs a wide range of motion.

These joints are divided into three categories, based on the number of axes of motion provided by each. An axis in anatomy is described as the movements in reference to the three anatomical planes: transverse, frontal, and sagittal.

Thus, diarthroses are classified as uniaxial, biaxial, or multiaxial joints.

Uniaxial joint

A **uniaxial joint** only allows for a motion in a single plane (around a single axis). The elbow joint, which only allows for bending or straightening, is an example of a uniaxial joint.

Biaxial joint

A **biaxial joint** allows for motions within two planes. An example of a biaxial joint is a meta-carpo phalangeal joint (knuckle joint) of the hand. The joint allows for movement along one axis to produce bending or straightening of the finger, and movement along a second axis, which allows for spreading of the fingers away from each other and bringing them together.

Multi axial joint

A joint that allows for the several directions of movement is called a **multi axial joint** (sometimes called polyaxial or triaxial joint). This type of diarthrotic joint allows for movement along three axes. The shoulder and hip joints are multiaxial joints. They allow the upper or lower limb to move in an anterior-posterior direction and a medial-lateral direction. In addition, the limb can also be rotated around its long axis. This third movement results in rotation of the limb so that its anterior surface is moved either toward or away from the midline of the body.

Law of reciprocal proportions

The law of reciprocal proportions was proposed by Jeremias Ritcher in 1792.

The **law of reciprocal proportions** states that, "If two different elements combine separately with a fixed mass of a third element, the ratio of the masses in which they do so are either the same as or a simple multiple of the ratio of the masses in which they combine with each other".

Although this law may seem complicated, it is fairly easy to understand with an **Example.**

For example, 3 g of C react with 1 g of H to form methane.

Also, 8 g of O react with 1 g of H to form water.

- The mass ratio of C:O=3:8.
- In the same way, 12 g of C react with 32 g of O to form CO2.

The mass ratio of C:O = 12:32 = 3:8.

The mass ratio in which C and O combine with each other is the **same as** the mass ratio in which they separately combine with a fixed mass of H.

Similarly, 12 g of C react with 16 g of O to form CO.

Here, the mass ratio of C:O = 12:16 = 3:4.

The mass ratio in which they separately react with a fixed mass of H is 3:8.

The **ratio of the two ratios** is 3/43/8=84=21.

Here, the ratio in which C and O combine with each other is **twice** the ratio in which they separately combine with a fixed mass of H.

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Question: 5- What is meaning and types of muscles contraction.

Muscular system is very important as it can produce movement and provide protection and support for organs in the body. The unique, characteristic feature of muscle cell is the relative abundance and organization of actin and myosin filaments within the cells. These filaments are specialized for contraction. There are three muscle types present in vertebrates; namely, smooth muscles, skeletal muscles, and cardiac muscles. The contraction of cardiac and smooth muscles is, generally, involuntary while the skeletal muscle is under voluntary control. Depending on the pattern of tension production, muscle contraction can be classified as isotonic contraction and isometric contraction. Daily activities involve both isotonic and isometric contraction combinations of the muscles.

Muscle contractions are defined by the changes in the length of the muscle during contraction.

Our body is made up of about 640 muscles. Without them we cannot live. They keep the skeleton balance and make it move. They have important role in renewing energy, and producing heat in human body.

Muscles are the moving force behind our movements. They along with the bones enable us to exercise the body in various ways. Muscles are attached to the bones of the skeleton. They give a round shape to the body and also help in the protection of some organs along with the bones. Muscles provide the energy for the movement by converting the stores of potential energy found in the muscle cells into mechanical energy in the form of work and heat.

The term muscle is derived from the Latin ‘ musculus ‘ meaning "little mouse" perhaps because of the shape of certain muscles or because contracting muscles look like mice moving under the skin.

Characteristics of muscles

Muscle cells have 4 primary properties:

Contractility

Muscle tissue has the ability to contract and shorten. Muscles can actively shorten, but they cannot actively lengthen themselves. They must rely on their antagonist muscle(s) or other external forces such as gravity to help them lengthen.

Excitability

This is the characteristic of muscle tissue that describes the muscle’s ability to respond to a stimulus. When a motor neuron sends a signal to the muscle, it contracts.

Extensibility

This means that muscle tissue can be stretched. When there is tightness of a muscle group, for example at the hamstring or pectoral muscles, it is usually *not* the muscle tissue itself that is the problem.

The tightness usually comes from restrictions in the fibrous connective tissue (fascia) that surrounds the muscle tissues. This is why massage techniques like myofascial release are so effective and lengthening muscles and restoring range of motion. This is also why low-load, long duration (LLLD) stretching is an effective stretching technique and reduces fascia restrictions.

Elasticity

This is the ability of muscle tissue to recoil or come back to its original length after being stretched.

Function of Muscle Contraction:

Muscles serve several purposes in human body. Human muscles contract for any number of reasons, but they primarily do the following:

- **Offer stability to your joints and connective tissues** – Human muscles lengthen and shorten, sometimes involuntarily, as your body needs them.
- **Produce heat to maintain human body temperature** – Around 40% of your body's temperature converts into muscle work. Shivering is your body's response to feeling cold, and your skeletal muscles activate to warm your body.
- **Maintain posture** – Muscles help you maintain a position like sitting or standing.

<u>Types of muscle contraction:</u>

There are three types of muscle contractions and they are defined by the changes in the length of the muscle during contraction.

Muscle contraction during exercise is divided into three categories depending on how the muscle contacts and whether it is lengthening or shortening.

1. Isotonic muscles contraction
2. Isometric muscles contraction
3. Isokinetic muscles contraction

<u>Isotonic muscles contraction:</u>

The word "isotonic" is derived from two Greek words: "iso," meaning "same," and "tonikos," meaning tension. As such, an **isotonic contraction** is one in which the muscle maintains the same tension as it shortens. These types of contraction occur when a muscle contracts and changes length.

Examples of activities that involve **isotonic contractions** include walking, running or lifting a light object.

Isotonic contraction can be further divided into two categories:

- **Isotonic concentric contraction** – this involves the muscle shortening. The origin and insertion of the muscle move closer together and the muscle becomes fatter.
  Example: Isotonic concentric contraction is bending the elbow from straight to fully flexed, causing a concentric contraction of the Biceps Brachii.
  Concentric contractions are the most common type of and occur frequently in daily and sporting activities.
- **Isotonic eccentric contraction** – Eccentric contractions are the opposite of concentric contractions and occur when the muscle lengthens as it contracts. This involves the muscle lengthening whilst it is under tension. The origin and the insertion move further away from each other. An eccentric contraction provides the control of a movement on the downward phase and it works to resist the force of gravity.

Example- Eccentric contractions occur when lowering the dumbbell down in a bicep curl exercise. The muscle is still contracting to hold the weight all the way down but the bicep muscle is lengthening.

<u>Isometric muscles contraction:</u>

Let's move on to isometric contractions. Isometric literally means 'same length,' where again 'iso'- means 'the same' and here 'metric' refers to length –

Isometric contractions, however, occur while the muscle stays at the same length and the joint angle stays at the same position.Isometric contractions occur when there is no change in the length of the contracting muscle. These types of contraction occur involves a muscle producing tension but staying the same length.

This type of contraction occurs when the body is fixed in one position. This occurs when carrying an object in front of you as the weight of the object is pulling your arms down but your muscles are contracting to hold the object at the same level.

Example:

Isometric contractions are when you grip something, such as a tennis racket. There is no movement in the joints of the hand, but the muscles are contracting to provide a force sufficient enough to keep a steady hold on the racket.

Another example of this type of contraction seen in the context of a bench press would be that a yielding isometric would be holding the bar at a given place

Isokinetic muscles contraction

Isokinetic contractions are similar to Isotonic in that the muscle changes length during the contraction, where they differ is that Isokinetic contractions produce movements of a constant speed.

Example

Example of Isokinetic muscle contraction:

Examples of using Isokinetic contractions in the day-to-day and sporting activities are rare.

The best is breaststroke in swimming, where the water provides a constant, even resistance to the movement of adduction.

In gymnastic roman ring events the muscles are contracting isometrically to hold this gymnast in the crucifix position and are not changing length. When the isometric contractions end, isotonic contraction will occur.

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Question: 6- Describe the meaning of joints, their function and Classification of Joints

Meaning of Joints

Joints are articular surface can be defined as a point where two or more bones are connected in a human skeletal system.

Functions of Joints

The primary functions of Joints are to connect bones within our body. Apart from this, it also helps us to move, rotate and also bear body weight.

Classification of Joints

Joints provide the means for movement. The type and characteristics of a given joint determine its degree and type of movement. Joints can be classified based on structure and function. There are two different types of joints-

1. **Structural Classification of Joints**
2. **Functional Classification of Joints**

Structural Classification of Joints

According to the structural classification of joints, they are divided into 3 types, namely:

Fibrous Joints / Fixed Joints

Fixed joints, also called immovable joints, are found where bones are not flexible. In such joints, bones have been fused together in such a way that they are fixed to that part, most commonly to create a structure. A prominent example of a fixed joint is the skull, which is made up of a number of fused bones.

Other examples include the upper jaw, rib cage, backbone, and pelvic bone, etc.

Cartilaginous Joints / Slightly Moveable Joints

Cartilaginous joints are partly movable joints comprising of symphysis or synchondrosis joints. These joints occur only in those regions where the connection between the articulating bones is made up of cartilage. Synchondrosis are temporary cartilaginous joints which are present in young children and last until the end of their puberty.

For example, the epiphyseal plates present at each end of the long bones is responsible for bone growth in children. The symphysis or the secondary cartilaginous joints (the place where bones join) is permanent. Examples include the pubic symphysis.

Other examples of cartilaginous types of joints include the spinal column and the ribcage.

Synovial Joints / Freely Movable Joints

The synovial joints are the most common type of joint because this joint helps us to perform a wide range of motion such as walking, running, typing and more. Synovial joints are flexible, movable, can slide over one another, rotatable and so on.

Examples of Synovial Joints ;These joints are found in our shoulder joint, neck joint, knee joint, wrist joint, etc.

Functional Classification of Synovial Joints / Freely Movable Joints

Functional classification of joints is based on the type and degree of movement permitted. Classification of joints based upon the degree of movement of joint permitted. There are six types of freely movable joint and are mentioned below with the examples:

Ball and Socket Joints

Here, one bone is hooked into the hollow space of another bone. This type of joint helps in rotatory movement. An example ball and socket joint are the shoulders.

Pivotal Joints

In this type of joint, one bone has tapped into the other in such a way that full rotation is not possible. This joint aid in sideways and back-forth movement. An example of a pivotal joint in the neck.

Hinge Joints

Hinge joints are like door hinges, where only back and forth movement is possible. Example of hinge joints is the ankle, elbows, and knee joints.

Saddle Joints

Saddle joint is the biaxial joint that allows the movement on two planes–flexion/extension and abduction/adduction. For example, the thumb is the only bone in the human body having a saddle joint.

Condyloid Joints

Condyloid joints are the joints with two axes which permit up-down and side-to-side motions. The condyloid joints can be found at the base of the index finger, carpals of the wrist, elbow and the wrist joints. This joint is also known as a condylar, or ellipsoid joint.

Gliding Joints

Gliding joints are a common type of synovial joint. It is also known as a plane or planar joint. These types' joint are permit two or more round or flat bones to move freely together without any rubbing or crushing of bones. This joint is mainly found in those regions where the two bones meet and glide on one another in any of the directions. The lower leg to the ankle joint and the forearm to wrist joint are the two main examples of gliding joints.

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Question: 7 - Describe the Anatomical terms of movement are used to describe the actions of muscles upon the skeleton

Anatomical terms of movement are used to describe the actions of muscles upon the skeleton. Muscles contract to produce movement at joints, and the subsequent movements can be precisely described using this terminology.

The terms used assume that the body begins in the anatomical position. Most movements have an opposite movement – also known as an antagonistic movement. We have described the terms in antagonistic pairs for ease of understanding.

Flexion and Extension

Flexion and extension are movements that occur in the sagittal plane. They refer to increasing and decreasing the angle between two body parts:

Flexion

Flexion refers to a movement that decreases the angle between two body parts. Flexion at the elbow is decreasing the angle between the ulna and the humerus. When the knee flexes, the ankle moves closer to the buttock, and the angle between the femur and tibia gets smaller.

Extension

Extension refers to a movement that increases the angle between two body parts. Extension at the elbow is increasing the angle between the ulna and the humerus. Extension of the knee straightens the lower limb.

Abduction and Adduction

Abduction and adduction are two terms that are used to describe movements towards or away from the midline of the body.

Abduction

Abduction is a movement away from the midline – just as abducting someone is to take them away. For example, abduction of the shoulder raises the arms out to the sides of the body.

Adduction

Adduction is a movement towards the midline. Adduction of the hip squeezes the legs together.

In fingers and toes, the midline used is not the midline of the body, but of the hand and foot respectively. Therefore, abducting the fingers spreads them out.

Circumduction

Circumduction can be defined as a conical movement of a limb extending from the joint at which the movement is controlled.

It is sometimes talked about as a circular motion, but is more accurately conical due to the 'cone' formed by the moving limb.

Medial and Lateral Rotation

Medial and lateral rotations describe movement of the limbs around their long axis:

Medial rotation

Medial rotation is a rotational movement towards the midline. It is sometimes referred to as internal rotation. To understand this, we have two scenarios to imagine. Firstly, with a straight leg, rotate it to point the toes inward. This is medial rotation of the hip. Secondly, imagine you are carrying a tea tray in front of you, with elbow at 90 degrees. Now rotate the arm, bringing your hand towards your opposite hip (elbow still at 90 degrees). This is internal rotation of the shoulder.

Lateral rotation

Lateral rotation is a rotating movement away from the midline. This is in the opposite direction to the movements described above.

Elevation and Depression

Elevation

Elevation refers to movement in a superior direction (e.g. shoulder shrug),

Depression

Depression refers to movement in an inferior direction.

Pronation and Supination

Pronation and supination are terms used to describe the motions observed at the foot and ankle during movement.

Supination

With your hand resting on a table in front of you, and keeping your shoulder and elbow still, turn your hand onto its back, palm up. This is the supine position, and so this movement is supination.

Pronation

Again, keeping the elbow and shoulder still, flip your hand onto its front, palm down. This is the prone position, and so this movement is named pronation.

Supination and pronation are terms used to describe the up or down orientation of your hand, arm, or foot.

Dorsiflexion and Plantarflexion

Dorsiflexion and plantarflexion are terms used to describe movements at the ankle. They refer to the two surfaces of the foot; the dorsum (superior surface) and the plantar surface (the sole).

Dorsiflexion

Dorsiflexion refers to flexion at the ankle, so that the foot points more superiorly. Dorsiflexion of the hand is a confusing term, and so is rarely used. The dorsum of the hand is the posterior surface, and so movement in that direction is extension. Therefore we can say that dorsiflexion of the wrist is the same as extension.

Plantarflexion

Plantarflexion refers extension at the ankle, so that the foot points inferiorly. Similarly there is a term for the hand, which is palantarflexion.

Inversion and Eversion

Inversion and eversion are movements which occur at the ankle joint, referring to the rotation of the foot around its long axis.

Inversion

Inversion involves the movement of the sole towards the median plane – so that the sole faces in a medial direction.

Eversion

Eversion involves the movement of the sole away from the median plane – so that the sole faces in a lateral direction.

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BIOMECHANICS

Question: 1- Define what is Biomechanics and Importance of bio-mechanics in the field of physical education and sports?

Question: 2 - What are the laws of motion? Explain the Newton's Laws of Motion and their application of these laws in sports activities?

Question: 3- Short Notes

1. Balance and Unbalance Force
2. **Joint action of human body working of three basic types of levers.**
3. **Application of Mechanical Concepts**
4. **Centripetal & Centrifugal Force**
5. **Line of Gravity**

Question-4- Describe the meaning friction? Explain their types with example of sports, and advantage and disadvantage of Friction in the field of sports and games.

Question: 5 - What is Lever Systems? Their parts types and functions with example of sports activities.

Question: 6- Define and various types of motion in sports.

Question: 7- Explain the meaning, definition, types and factors responsible for Equilibrium.

Question: 8 - Explain the meaning, definition, condition (Static and Dynamic Equilibrium) and principles of Equilibrium.

Question: 9 - Explain meaning definition and roll of Center of Gravity in sports.

Question: 10- Explain the meaning, definition, types and importance of forces in physical education and sports.

Question: 11- Explain meaning definition and roll of Center of Gravity in sports.

Question: 12 – Define Meaning, Types and Importance and advantage of good and poor posture.

Question: 13- Define with example and difference the term Distance and displacement.

Question: 14- What is force? Explain in detail about the type of forces.

Question; 15- What is the meaning and types of balance? How to improve the balance?

Question; 16- Define in detail the term and fundamental differences between Kinetics and Kinematics

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Question-1-: Define what is Biomechanics and Importance of bio-mechanics in the field of physical education and sports?

Meaning of Biomechanics:

Biomechanics is derived from two Greek words. (Bio + Mechanics)

"Bio"-means living things

"Mechanics" is field of physics.

Thus, it the branch of science, which deals with the forces related to body movements, is known as Biomechanics.

Definition of Bio-mechanics:

- Biomechanics is defined as systematic study of mechanics of body joints.

- **According to Wikipedia,** "Biomechanics is the study of structure and function of biological
  systems of humans."
- Biomechanics is a branch of mechanics that deals with the geometry of the motion of objects, including displacement, velocity, and acceleration, without taking into account the forces that produce the motion

Biomechanics is the study of the structure and function of the mechanical aspects of biological systems, at any level from whole organisms to organs, cells and cell organelles, using the methods of mechanics.

Biomechanics is traditionally divided into two areas:

1. Kinematics:
2. Kinetics

Kinematics:

Which is a branch of mechanics that deals with the geometry of the motion of objects; including displacement, velocity, and acceleration, without taking into account the forces that produce the motion

Kinetics

Kinetics is the study of the relationships between the force system acting on a body and the changes it produces in body motion.

Area of Study of Biomechanics:

Biomechanics focuses on the application of the scientific principles of mechanical physics to understand the movements of the actions of human bodies and sports implements. In this view the area of biomechanics related with biological aspects of human body and Mechanics (Mechanical aspects).

Biological aspects of human body:

Its includes skeleton, muscular and nevous systems. For example- bones, muscles and nerves work simultaneously in producing motion. Bones act as levers and muscles with the help of nervous system produces the motion.

Mechanical aspects of human body:

Its includes the laws of physics related to the motion or human movement. Mechanics also includes the static and dynamics. In static, studies the factors related to non- moving systems. In Dynamics the study of mechanical factors that relate to systems in motion. As a matter of fact, there are various bio mechanicals terms which are related to human action. Example: Force, motion, momentum, laws of motion etc.

Importance of Bio-mechanics in Physical Education and Sports:

Biomechanics is the sport science field that applies the laws of mechanics and physics to human performance, in order to gain a greater understanding of performance in athletic events through modeling, simulation and measurement. It is also necessary to have a good understanding of the application of physics to sport, as physical principles such as motion, resistance, momentum and friction play a part in most sporting events. Importance of biomechanics in Sports as follows:

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.

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.

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

Improve in the training techniques:

A teacher can analyze the player's movement or action with the help of the biomechanical principles. It helps in improving the training techniques.

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.

Helps in understanding human body:

It gives the knowledge of different systems of our body. For'example, nervous system, muscular system and skeletal system.

Knowledge of safety principles:

Biomechanics gives the understanding to analyze different movements that can harm the player. The teachers remove those unnecessary and harmful movements.

Helps in research work:

Biomechanics helps in teaching and learning process, it also helps the teacher to acquire precision and accuracy of movement.

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.

Helps in maintaining healthy body:

Principals of biomechanics, gives us 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.

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.

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Question: 2 - What are the laws of motion? Explain the Newton's Laws of Motion and their application of these laws in sports activities?

Newton's Laws of Motion:-

Sir Isaac Newton stated three laws which explain the relationship between force and movement. Having an understanding of Newton's laws which you can apply to sporting situations gives you a deeper understanding of sports technique. Newton's Three Laws of Motion explain how forces create motion in sport. These laws are usually referred to as the Laws of Inertia, Acceleration, and Reaction.

Newton's First Law of Motion:

It is also known as Law Inertia. Newton's First Law was a restatement of Galileo's concepts of motion; however Galileo only explained how things move. Newton explained why things move. Newton's First Law states can be broken into two statements.

Statement-1-A body at rest will remain at rest,

Statement-2- A body in motion will remain in motion unless it is acted upon by an external force.

This simply means that things cannot start, stop, or change direction all by themselves. It takes some force acting on them from the outside to cause such a change. This property of massive bodies to resist changes in their state of motion is sometimes called inertia. Inertia is the bodies' resistance to change in motion and is related to mass. If you want to get an object with a large mass moving you have to apply more force than if you want to get a tiny object moving. It really is that simple. Likewise if you want to slow down or stop a heavy object you will need to apply a greater force to it than if you want to slow down a small object Inertia is the reluctance of a body to change whether it is moving or not and is related to its mass. Once a body is moving the momentum of the body is a product of its mass multiplied by its velocity.

The law of inertia is divided into two parts;

1. State of rest
2. State of motion

State of rest:

"An object at rest will remain at rest until acted upon by a force".

In first law of motion involves equation F=ma, where 'F' denote for force, 'm' denote for mass and 'a' denote for acceleration. If F = 0, so acceleration also will be zero the body will be in the state of rest.

Example:

A book place on the table and football place on the ground for kick off.

State of motion:

"An object in motion will remain in motion in a straight line at a constant speed until acted upon by a force".

When applying some force on body which in state or rest, resulted in Motion body moves in direction of force in uniform motion until some force applied for change the direction of object. We can see when we kick the ball it will be in motion and after some time at some distance it will become in state of rest due to applying a various forces on its i.e. gravitational force, friction and anti-air force or air resistance.

Explanation:

When a force acts upon an object in motion, the movement (speed and/or direction) of the object changes. The effect of a force on a moving object may cause the object to either increase its speed or decrease its speed. A change in motion is called acceleration. When determining the force acting on object under Newton's First Law of Motion, the force evaluated is the net force. The net force is the result of all forces acting on an object. Under Newton's First Law, when the net force is zero, an object in motion remains in motion. Similarly, when the net force is zero an object at rest remains at rest.

Under Newton's First Law, a moving object's inertia is related to speed of the object as caused by the net force acting upon it and the mass of the object. The greater the speed of a moving object, the more inertia it has. The mass of an object is the amount of material contained in an object. An object's mass depends on the number and kinds of atoms contained in the

object. The greater the mass of a moving object, the more inertia it has. In his First Law, Newton explained the effect of a net force, greater than zero, upon an object at rest.

Example:

In Football:

Newton's first law plays a role in soccer. The soccer ball, when kicked, keeps going forward until air resistance, friction, a person, or another object like a wall stops it. When a soccer ball is resting none moving on the ground, it will stay like that until someone kicks it or another force acts upon it.

In Athletics Long Jump Event:

During the long jump event, It can be clearly seen that the body of a jumper first in state of inertia. When force is applied to accelerate, the body angle will change. During the run up the center of gravity will vary.

In Game of Golf

A golf ball will remain still unless the force applied by the golf club makes it move or that same golf ball will continue to move at a constant velocity (speed in a straight line) unless a force acts on it to slow it down (e.g. air resistance) or change its direction (e.g. gravity).

In Game of Volleyball:

A nice example of the law of inertia can be seen in a volleyball at the highest arc of a server toss, that moment when the ball is nearly motionless. It will either fall straight down due to the force of gravity, or sail across the net from the force of a hand striking it. In an example of a moving object, a spiked volleyball moves in a fairly straight line downwards unless deflected by the force of the net, receiver's forearms, blocker's hands or floor.

In Equestrian Sports:

When the horse is motion then rider also remain in motion along with the horse. But when the stops horse suddenly, the lower part of the rider comes to rest along with the horse nut rider upper part remains in motion. To save himself falling from the horse the rider that why he falls forward.

Factors affecting the Ist Law of Motion:

Most anything in the real world is- gravity, the surface of the playing field, a defensive player and breaking action of an athletes' stop , so many example are seen in the activity of sports.

Newton's Second Law of Motion

Also it is known as Law of momentum.

This law states that the acceleration of an object is directly proportional to the force applied on the object, it inversely proportional to its mass. When a force acts on an object, the rate of change of Momentum experienced by the object is proportional to the size of the force and takes place in the direction in which the force acts.

"Newton's second Law of Motion states that **"the rate of change of momentum is directly proportional to the force applied in the direction of force."**

In the game of billiard or Snooker white ball strike the yellow ball with a force yellow ball move forward in the direction of force

It states, "The force acting on an object is equal to the mass of that object times its acceleration." This is written in mathematical form as **F** = ma, where **F** is force, **'**m**'** is mass, and '**a' is** acceleration. The bold letters indicate that force and acceleration are vector quantities, which means they have both magnitude and direction. The force can be a single force, or it can

be the vector sum of more than one force, which is the net force after all the forces are combined.

Second Law of Motion (F= ma) explains the relationship between force and acceleration in motion. The application of force on an object causes an acceleration of that object. Yet, force is not the only factor in the movement, or acceleration of an object. The two main influences on the acceleration of an object are net force and mass.

For example,

1-Net force is directly proportional to acceleration

2- While mass is inversely proportional to acceleration.

In other words, net force- the force that has overcome friction and accelerates an object- is directly linked to acceleration; the more force you have, the faster an object goes

When a constant force acts on a massive body, it causes it to accelerate, i.e., to change its velocity, at a constant rate. In the simplest case, a force applied to an object at rest causes it to accelerate in the direction of the force. However, if the object is already in motion, or if this situation is viewed from a moving reference frame, that body might appear to speed up, slow down, or change direction depending on the direction of the force and the directions that the object and reference frame are moving relative to each other.

Explanation;

Newton's Second Law explains that the acceleration of an object is effected by the net Force applied to the object and the mass of the object. When acceleration is applied on a moving vehicle, the momentum of the vehicle increases and the increase is in the direction of motion because the force is being applied in the direction of motion. On the other hand, when brake is applied on the moving vehicle, the momentum of the vehicle decreases and the decrease is in the opposite direction of motion because the force is being applied in the opposite direction of motion.

Momentum is important in sport, particularly contact sports where collisions are involved. The more momentum a rugby player has the harder it is to stop her. This simply means in Golf, when the Golfer above is struck by the golf club the rate of change of Momentum (or velocity) of the ball is proportional to the size of the force acted on it by the club. A popular way of describing Newton's second law of motion, particularly when doing calculations is

F= ma

Force = mass x acceleration

The Second Law gives us an exact relationship between force, mass, and acceleration.

According to the relation obtained above, Newton's Second Law can be modified as follows:

The product of mass and acceleration is the force acting on the object.

Force is the cause of acceleration. Net force is measured in units called Newton. One or more forces may be applied to an object to make it move. The net effect of the forces acting on an object is called the net force. Net force also influences the direction of the acceleration. An object accelerates in the same direction as the net force acting on the object. The net force acting on an object is directly proportional to that object's acceleration, which means the greater the net force, the greater the acceleration.

The mass of an object is also a key factor determining the effect of force upon an object. Mass is one of the obstacles that inhibits motion and acceleration. Mass is inversely related to acceleration, so if the force is constant then as the mass of an object increases acceleration

decreases. Therefore, unlike force where if you double the force the resulting acceleration also doubles, if you double the mass of an object you will reduce the acceleration by half.

You have applied this formula if you have ever pushed two people of different masses on the swings and noticed that if you pushed both people with the same force, the person with the lesser mass swung higher than the person of greater mass. The reason is the acceleration of an object being pushed is effected by the mass of the object itself. As a result, if the same force is applied to two objects, the object with the lesser mass will have a greater resulting acceleration than the object with the greater mass.

The Second Law gives us an exact relationship between force, mass, and acceleration.

According to the relation obtained above, Newton's Second Law can be modified as follows:

The product of mass and acceleration is the force acting on the object.

1- The second law affects the Speed of the ball and the player. The more weight the ball has, the slower it goes.
2- The more weight the player has, the slower he can run. Heavier people kick farther than lighter people. Lighter people can run faster than heavier people. More force more acceleration.

Example:

In Athletics:

1- For athletes of long and high jump sand bed or cushioned bed (Landing Pit) is provided to allow a changed of momentum to zero because of jumping of athlete.

When an athlete falls on the ground after performing a high or long jump, the momentum because of the velocity and mass of the athlete is reduced to zero. If the momentum of an athlete will be reduced to zero instantly, the force because of momentum may hurt or injured the player. By providing a cushioned landing area, the reduction of the momentum of the athlete to zero is delayed. This prevents the athlete from getting injured.

2- In sprint races, When a sprinter finishing a race, due to inertia (the tendency of an object (Sprinter) is to remain in motion or at rest) sprinters struggle while stopping at the finish line because it requires a very sudden change in motion.

3- In throwing events like shot-put and discus throw involve use of Newton's second law of Motion, because the shot-put, which is much heavier than the discus, has to throw with greater force than the discus so as to teach the same acceleration.

In Cricket:

A fielder pulls his hand backward; while catching a cricket ball coming with a great speed, to reduce the momentum of the ball with a little delay.

According to Newton's Second Law of Motion; rate of change of momentum is directly proportional to the force applied in the direction.

While catching a cricket ball the momentum of ball is reduced to zero when it is stopped after coming in the hands of fielder. If the ball is stopped suddenly, its momentum will be reduced to zero instantly. The rate of change in momentum is very quick and as a result, the player's hand may get injured. Therefore, by pulling the hand backward a fielder gives more time to the change of momentum to become zero. This prevents the hands of fielder from getting injured.

In the game of Volleyball

The law of acceleration comes into play every time a volleyball player moves on the court.

Smaller athletes are more agile on the court because their lower mass accelerates and decelerates more quickly, which is particularly critical on defense. Heavier athletes need more time to get into position, or more leg strength to get there as quickly. The faster the arm swing, the more force is exerted on a spiked volleyball at the moment of contact.

If a player improves leg strength through training while maintaining the same body mass, they will have an increased ability to accelerate the body using the legs, resulting in better agility and speed. This also relates to the ability to rotate segments, as mentioned above.

Newton's Third Law of Motion

Newton third law of motion is also known as action and reaction. An action may be a push or a pull. Third Law states that if one object applies a force on a second object then there is interaction between the objects. Newton refers to this interaction in terms of *action* and *reaction.*

In his Third Law, Newton explains that the object that acts upon a second object is also acted upon by the second object. The action by the second object upon the first object is equal in force to the action of the first object.

People commonly summarize Newton's Third Law by saying for every action there is an equal and opposite reaction.

Newton's Third Law of Motion states that

"For every action there is always an equal and opposite reaction."

Third law describes what happens to a body when it exerts a force on another body. Forces always occur in pairs, so when one body pushes against another, the second body pushes back just as hard.

For example:

a. When you push a cart, the cart pushes back against you;

b. When you pull on a rope, the rope pulls back against you;

c. When gravity pulls you down against the ground, the ground pushes up against your feet;

d- When a rocket ignites its fuel behind it, the expanding exhaust gas pushes on the rocket causing it to accelerate.

Explanation:

Whenever a force is applied over a body, that body also applies same force of equal magnitude in opposite direction.

Example –

Tennis:

When a Tennis player hits a ball the racket exerts a force on the ball and the ball exerts an equal and opposite force on the racket. The racket exerts what is known as the action force and the ball exerts the reaction force which is felt by the increased resistance at the time the racket strikes the ball.

If the same ball then hits the floor it exerts a force on the floor and the floor exerts an equal and opposite force on the ball. There is always reaction for every action in opposite direction and of equal magnitude. It is also known as law of action and reaction.

In Athletics –

1- **Walking in Athletics**

A person is able to walk because of the Newton's Third Law of Motion. During walking, a person pushes the ground in backward direction and in the reaction the ground also pushes the person with equal magnitude of force but in opposite direction. This enables him to move in forward direction against the push.

Action: the force exerted by the feet on the ground (down and backward)
Reaction: the force of the ground or the Ground reaction force (up and forward)

2- In sprints races, the sprinter' starting blocks based on Newton's third law of motion, where the sprinter is propelled forward during the start of the race due to a reaction from the starting blocks.

Recoil of gun –

In Shooting events, when bullet is fired from a gun, the bullet also pushes the gun in Opposite direction, with equal magnitude of force. This results in gunman feeling a backward push from the butt of gun.

Propulsion of a boat in forward direction –

In Boating when a Sailor pushes water with oar in backward direction; resulting water pushing the oar in forward direction. Consequently, the boat is pushed in forward direction. Force applied by oar and water are of equal magnitude but in opposite directions.

In Game of Volleyball:

The law of action and reaction forces can be seen when volleyball players leap off the floor. The force exerted by their feet downwards is countered by an opposing, upwards force exerted by the floor. If the floor didn't "push back," athletes wouldn't be able to leave the ground. The opposing force from the floor, by the way, is also why people get sore feet after a long practice session and bruised from hitting the floor after a hard dig.

Swimming:

1- **Diving:**

When a diver, dive off of a diving board, he push down on the springboard. The board springs back and forces you into the air.

2- Swimming event:

In swimming race, the swimmer pushes the water with his hands and thus water attain a push due to equal and opposite reaction from water.

Application Newton's law of motions in sports activities:

These three laws all relate to force and the motion of objects. They are highly relevant for sport and games activities and the biomechanical principles of human movement.

1. The force created by the legs "pushing" against the ground results in ground reaction forces in which the ground "pushes back" and allows the player to move across the court (As the
2. Earth is much more massive than the player, the player accelerates and moves rapidly, while the Earth does not really accelerate or move at all).
3. This action-reaction also occurs at impact with the ball as the force applied to the ball is matched with an equal and opposite force applied to the racket/body.
4. When a Tennis player hits a ball the racket exerts a force on the ball and the ball exerts an equal and opposite force on the racket.
5. If the same ball then hits the floor it exerts a force on the floor and the floor exerts an equal and opposite force on the ball.
6. Any activity that is carried out at a steady pace in a consistent direction will conserve energy (e.g., walking, jogging, dancing)
7. Any activity that is carried out at an irregular pace in different directions will be costly in energy expenditure and fatiguing (e.g., basketball, volley ball)
8. Greater force is required to accelerate a football compared to a baseball because of their mass difference

9. A much greater force is required from the muscles to accelerate an 80kg man than to accelerate a 50kg man to the same running speed

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Short Notes:3

- **Difference between Balance and Unbalance Forces**
- **Joint action of human body**
- **Application of Mechanical Concepts**
- **Centripetal & Centrifugal Force**
- **Line of Gravity:-**

Difference between Balance and Unbalance Forces

A force is a push or a pull which alters the state of motion of a body and is measured in Newton's (N). As explained in Newton's first law of motion a force is required to make a stationary body move, change speed, direction or stop.

Balance Force

When the forces on an object produce a net force of 0 N, the forces are balanced. •There is no change in the motion of the object

Unbalance Forces

When the net force on an object is not 0 N, the forces on the object are unbalanced. Unbalanced forces produce a change in motion of an object. Friction forces on the ground prevent the blue player from sliding. Gravity also acts on both fighters.

Comparison between Balanced and Unbalanced Forces:

Basis For Comparison	**Balanced Forces**	**Unbalanced forces**
Meaning	When the forces exerted on the object, are of equal size but in opposite direction, then the	When the forces applied on the object are unequal in size, then the forces are known as unbalanced forces.
Magnitude	Equal	Unequal
Direction	Opposite	Same or Opposite
Stationary Object	Stays at rest	Moves in the direction of greater force
Moving Object	Continues to move in the same speed	Changes its speed and direction.
Net force	Zero	Non-Zero

Short notes - Joint action of human body can be described from the working of three basic types of levers

Bones, ligaments, and muscles are the structures that form levers in the body to create human movement. In simple terms, a joint (where two or more bones join together) forms the axis (or fulcrum), and the muscles crossing the joint apply the force to move a weight or resistance. Levers are typically labeled as first class, second class, or third class. All three types are found in the body, but most levers in the human body are third class Human may not think of their limbs as being machines, but they are. The action of a muscle pulling on a bone often works like a type of simple machine called a lever.

1-A lever is a rigid rod able to rotate about a fixed point known as a fulcrum, formed by the joint.

2-Any force applied to the lever is called the effort.

3-A force that resists the motion of the lever, such as the downward force exerted by a weight on the bar, is called the load or the resistance.

The contraction of the muscles is the effort and the part of the body concerned is known as the resistance or load. Bones of the body act as levers (a mechanical device) which create a mechanical advantage of strength or speed.

Each of the three types of levers can be found in the human body. In each type of lever, notice where the fulcrum is located compared to the effort and the load. In your body, the effort is the force that your muscles apply to the lever. The load is the weight that resists the pull of your muscles.

Muscles and bones act together to form levers. In our bodies bones act as lever arms joints act as pivots, and muscles provide the effort forces to move loads. Levers can be used so that a small force can move a much bigger force. Different classes of levers are identified by the way the joint and muscles attached to the bone are arranged. Levers can also be used to magnify movement, for example, when kicking a ball, small contractions of leg muscles produce a much larger movement at the end of the lExample: Levers are able to give us a strength advantage or a movement advantage but not both together.

Different classes of levers are identified by the way the joint and muscles attached to the bone are arranged

First class lever – stand on tip toes

In a first class lever, the weight and force are on opposite sides of the fulcrum:
A small force can be used to advantage over a heavy weight if a long force arm or lever arm can be used.

Examples of this lever include scissors, crowbars, and teeter-totters.

For the Class 1 lever the pivot lies between the effort and load. A see saw in a playground is an example of a Class 1 lever where the effort balances the load. This pivot exists in the place where your skull meets the top of your spine. Your skull is the lever arm and the neck muscles at the back of the skull provide the force (effort) to lift your head up against the weight of the head (load). When the neck muscles relax, your head nods forward.

For this lever, the pivot lies between the effort and load. A see saw in a playground is another example of a Class -1 lever where the effort balances the load.
An example of a first-class lever is the joint between the skull and the atlas vertebrae of the spine: the spine is the fulcrum across which muscles lift the head.

Second class lever –(stand on tip toes)

In the second class lever, the load is between the fulcrum and the force:
A smaller effort can be used to advantage over a larger weight. An example of this lever is a wheelbarrow.

The pivot is at your toe joints and your foot acts as a lever arm. Your calf muscles and Achilles tendon provide the effort when the calf muscle contracts. The load is your body weight and is lifted by the effort (muscle contraction).

The load is between the pivot and the effort (like a wheelbarrow). The effort force needed is less than the load force, so there is a mechanical advantage. This muscular movement at the back of your legs allows you to move your whole body a small distance.
An example in the human body of a second-class lever is the Achilles tendon, pushing or pulling across the heel of the foot.

Third Class Lever (bend your arm)

In the third class lever, the force is between the fulcrum and the load:

In this case, there is no force advantage – force is not increased. In fact, a larger force is actually needed to move a smaller weight, so there is a force disadvantage. The use of this lever is in the gain in speed of movement of the weight.
Examples of this lever class include: The inside door handle of a car, the coiled spring pulling on a screen door, a pair of finger-nail clippers, and tweezers.

The pivot is at the elbow and the forearm acts as the lever arm. 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.

The load is further away from the pivot than the effort. There is no mechanical advantage because the effort is greater than the load. However this disadvantage is compensated with a larger movement – a small contraction of the biceps produces a large movement of the forearm. This type of lever system also gives us the advantage of a much greater speed of movement. An example of a third-class lever in the human body is the elbow joint: when lifting a book, the elbow joint is the fulcrum across which the biceps muscle performs the work.

Application of Mechanical Concepts

In the history of physical education and sports every sportsperson have been interested in enhancing their performance or do better in the field of sports. Mechanics is a branch of physics that is concerned with the description of motion/movement and how forces create motion / movement. In primary and high school standard whole stress is laid down on the learning the fundamental motor skills, which provide a base of learning motor skills effectively of advanced various sports related skills. It is important for coaches and physical education teachers have knowledge principles of biomechanics in the field of sports and games. With the knowledge of biomechanics they make their better efforts to improve the performance of their trainee. 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.

All motor activities such as walking, running, jumping, squatting, pushing, pulling, lifting, and throwing are examples of dynamic musculoskeletal mechanics. To better appreciate the sometimes simple and often complex factors involved, the basic concepts and terms involved in maintaining static equilibrium. Static equilibrium is the starting point for all dynamic activities.

In the modern era of sports, biomechanics is playing a very vital role in improving the standard and performance of every sports person.

Centripetal & Centrifugal Force

In the case of curvilinear motion, two types of force come into the picture, i.e., the centrifugal force and centripetal force. When an object is rotating around a fixed axis in a circular path, two opposing forces act on the object-

1. Centripetal Force
2. Centrifugal Force

Centripetal Force:-

Centripetal force is defined as, "the **force** that is necessary to keep an object moving in a curved path and that is directed inward toward the center of rotation,"

1. Causes object to move towards the center.

Example of Centripetal force

- **Spinning a ball on a string or twirling a lasso:** Here the centripetal force is provided by the force of tension on the rope pulls the object in toward the centre.

- **Turning a car:** Here the centripetal force is provided by the frictional force between the ground and the wheels.
- **Going through a loop on a roller coaster:** The force is provided by the Normal Force as the seat or wall pushes you toward the centre.
- **Planets orbiting around the Sun:** Centripetal Force is provided by Gravity.

Centrifugal Force-

Centrifugal force is defined as "the apparent **force** that is felt by an object moving in a curved path that acts outwardly away from the center of rotation," This force is called Centrifugal force.

1. Causes object to move away from the centre.

Examples of Centrifugal Force are given below.

2. Weight of an object at the poles and on the equator
3. A bike making a turn.
4. Vehicle driving around a curve
5. Equatorial railway

Differences Between Centripetal and Centrifugal Force	
Centrifugal Force	**Centripetal Force**
If an object moving in a circle and experiences an outward force then this force is called the centrifugal force.	If the object travels at a uniform speed in a circular path it is called centripetal force.
The object has the direction along the centre of the circle from the centre approaching the object	The object has the direction along the centre of the circle from the object approaching the centre.
Mud flying of a tire is one example of the centrifugal force.	A satellite orbiting a planet is an example of the centripetal force.

Line of Gravity:-

Line of gravity is an imaginary line that extends from the center of gravity to the base of support.

In the anatomical position the line of gravity is between the legs and feet right under the person. The location of this line in relation to the base of support has a huge influence on balance and stability's. The direction of gravity is the line of gravity and is always perpendicular to the ground.

The line of gravity is an imaginary vertical line passing from the centre of gravity to the ground
or surface the object or person is on. It is the direction that gravity is acting upon the person or object.

- When the line of gravity is within the base of support, an object or person is said to be stable.
- When the line of gravity falls outside the base of support, the object or person is said to be unstable.

The line of gravity is an imaginary vertical line from the centre of gravity to the ground or surface the object or person is on. It is the direction that gravity is acting upon the person or object. In the image above you can see the line of gravity in red going down to the ground from the centre of gravity, indicating the force of gravity upon the sprinter.

The closer the line of gravity is to the centre of the base of support the better balanced a person is in this position. If the line of gravity fall outside of the base of support the person must

provide corrective muscle action, usually movement otherwise they will fall. This is why the sprinter's line of gravity is in front of his base of support (back foot on the ground) because it must be there in order for him to be stable and move forwards. If the line is in his base of support and he starts running, he will fall backward, unless he moves the line to in front of him.

Since a lower center of gravity means better balance and stability, a shorter line of gravity between the center of gravity and the ground also means better balance and stability. So rugby player dodging through the defense will shift her line of gravity outside of her base of support in various directions as she changes direction and will also lower her centre of gravity.

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Question-4- Describe the meaning / define friction? Explain their types with example of sports. Advantage and disadvantage of Friction in the field of sports and games

Friction

Friction is found everywhere in our life, daily routine work such as walking, pulling an object from the floor and any moving object at earth or free falling.

According to the first law of motion "A body at rest will remain at rest ans a body in motion will remain in motion at the same speed and in the same direction unless acted on y the external force."

This law is adequately right but in practice it seems otherwise or opposite."

Example:

When a cricket ball or football is hit or kicked, it moves very fast in the direction of force on the ground. But after some time its motion become less and finally in static position or rest. Similarly, when a javelin, shot, discus or hammer is thrown, it moves in the direction of force applied but after travelling sometimes into the air, it comes down and touches the ground. The above mentioned examples show that there is invisible force (external force) that oppose the motion of the ball or athletics throwing equipment (No doubts that the force of gravitation also acct on the body). Thus, this opposing force is called friction. In this way it can said that force of friction is the force that develops at the surfaces on contact of two bodies and oppose their relative motion.

Definition of Friction:

Friction can be defined as the resistance to motion of two moving objects or surfaces that touch. Friction plays a very important role in many sports, such as bowling and curling.

Type of Friction

There two type of friction

1. Static Friction
2. Dynamic Friction.

Static friction

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

Example for static friction:

1. The friction between the shoe and the ground
2. The friction to keep the racket in hand
3. Friction between hand and ball to spin the ball

Dynamic friction:

Dynamic friction is the opposing force that comes into play when one body is actually moving over the surface of another body. Further dynamic friction may be two types:

1. Sliding friction
2. Rollinf friction

Sliding friction:

The opposing force that comes into play when one body is actually sliding over the surface of the other body is called sliding friction. Examples: sliding to base in baseball and planting the pole in pole vault

Example for Dynamic friction:

1. Ice skating,
2. Planting the pole in pole vault
3. Sliding to base in baseball

Rolling friction:

In rolling friction, the opposing force that comes into play when one body is actually rolling over the surface of the other body is called rolling friction.

Example of rolling friction:

1. In the game of hockey and football, when a hockey and football ball is hit/ kick, it rolls on the surface of the ground. It stops after some time due to rolling friction. Such type of friction is widely occurs or seen in sports and games activities.

Friction plays a big role in rolling sports such as tenpin bowling and curling. In tenpin, the friction resistance on the ball makes it slow down and also enables the spin on the ball to make it roll in an arc.

The mass and the surface composition of the ball and the amount of oil on the lane will affect the magnitude of the friction between the bowling ball and bowling lane. The more oil on the lane means the ball is slow down less and the harder it is for the bowler to send the ball in a curved path. Some sports related example are as follows:

1. Tennis:
   (Friction between ball and the air, the ball and the racket, the player's hand and the racket etc.)
2. Football:
   (Friction between the ball and the air, the ball and the ground, the player's foot and the ball etc.)
3. Snooker / 8 ball
   (Frictions between the ball and the table, the cue and the ball, the cue and the players hand etc.)

Advantage and disadvantage of Friction in the field of sports and games:

Friction plays a big role and it is essential without friction, any individual cannot give a better performance in the field of sports.

Advantage of Friction;

In the field of sports and games there is lot of examples how the friction is advantageous to the players. Some examples are described below;

1. In athletics sprinter and jumpers wear spikes and in football and hockey players uses studs to have better or appropriate friction while they run fast. Without friction they are unable move quickly or run fast.
2. Even in Gymnastic, gymnast also use lime powder on their palms to perform on horizontal bar, uneven bars and roman rings to have a friction.
3. Even in walking events, walking may be difficult due to less friction.

4. In weightlifting competition, weightlifter also used lime powder on their palms before holding the bar in snatch and jerk.
5. In badminton, the badminton players are usually seen to rub their soles of shoes with line before going to the wooden court.

Disadvantage of Friction;

The force of friction acts in the opposite direction that the object is moving, so friction slows down the motion of moving objects. In the field of sports and games there is lot of examples how the friction is disadvantageous to the players. Some examples are described below;

1. In cycling events, there should not be more friction between road and tyres of cycle. If there is more friction there will be more wastage of time and energy of the rider, more energy is needed to move faster. The tires must be fully inflated to reduce the friction in cycling.
2. In roller skating, there should be less friction for better performance.

In last we can say that, despite the fact that the *friction* is very important in our daily life. Without friction we are handicap, but it is advantageous in some sports but in other sports more frictions is disadvantageous. Up to some extent, some force of friction is required in various sports activities. The requirement may be differ or vary from sports to sports.

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Question: 5- What is Lever Systems? Parts types and functions with example of sports activities.

Introduction:

Biomechanics has linked our body with science. The bio-mechanical association of anatomy to forces which are acting and producing (or preventing) motion of the basis of lever.

Levers are one of the basic tools that were probably used in prehistoric times. Levers were first described about 260 BC by the ancient Greek mathematician Archimedes (287-212 BC). A lever is a simple machine that makes work easier for use; it involves moving a load around a pivot using a force.

Like this human body's mechanism for movement and although it may be viewed as a part of skeleton system, the role of muscles are attached to bones via tendons supplying necessary force and the bones of the skeleton act as levers, which muscles pull on to create movement.

What is Lever?

A lever is a device for transmitting energy. It is a mechanism that can be used it exert a large force at one end of the lever at a lesser distance from a fixed support (fulcrum) by exerting a small force at a larger distance from the fulcrum. Usually lever is referred as a rigid bar that moves on a fixed point or axis called the fulcrum, when a force is applied to it.

Many of our daily used basic tools based on levers, including scissors, pliers, hammer claws, nut crackers see-saw and tongs.

Movement is made possible in the human body by lever systems which are formed by our muscles and joints working together. An understanding of the lever systems in the body helps us to understand how movement is possible. Bony levers are motion less objects until they are moved by the muscles which in turn motionless until stimulated by the nervous system.

Definition of Lever:

A lever may be defines as "a rigid bar that is used to overcome resistance when a force is applied to one side of the fulcrum."

"A lever is a rigid bar that rotates around a fixed point and is used to apply force against a resistance."

Parts of Levers:

The functioning of lever is characterized by the three main parts.

1. Fulcrum
2. Force arm/Effort
3. Load/Resistance

Fulcrum:

Fulcurm is the support point on which lever pivots/ rotate/ turns about a fixed point known as a fulcrum. By the position of the fulcurm in relation to other two parts, determine the class of lever

Force arm/ Effort:

Any force applied to the lever is called the effort. It is the point at which the force applied

Load/ Resistance arm:

A force that resists the motion of the lever, such as the downward force exerted by a weight on the bar, is called the load or the resistance

It is the point at which object that is being moved by a lever.

Types of Lever:

Types of lever depending on the relative position of the three components:

1. Fulcrum- (F),
2. Effort -(E)
3. Load - (L).

A useful way of determining the different types of lever system operating during a particular movement is to remember the following rhyme:

This rhyme helps us to identify the middle component of each lever system:

For a 1st class lever system, --------- F (Fulcrum) is the middle component.

For a 2nd class lever system, --------- L (Load) is the middle component.

For a third class lever system, ------- E (Effort) is the middle component..

Functions of a Lever System:

Lever systems have two main functions;

1. To increase the resistance that a given force can move.
2. To increase the speed at which a body moves.

In addition, different lever systems allow different ranges of movement. It means that some lever systems are effective at overcoming a resistance, whilst others are able to generate speed.

First class lever system

In a first order of lever system is the simplest type of lever, the fulcrum is the middle component and lies between the effort and load. In this class of lever fulcurm may be moved alone the lever, there by changing the relative length of force arm and the resistancee, the force arm is lengthened and less force needed to be move the resistance a short distance. Conversly short end force arm requires greater force application, but in speed and range of motion at the resistance end

Example:

The place where your skull meets the top of your spine is a Class 1 lever. Your skull is the lever arm and the neck muscles at the back of the skull provide the force (effort) to lift your

head up against the weight of the head (load). When the neck muscles relax, your head nods forward.

Example in Sports Activities:

Examples of a first class lever system in the body are rare as few exercises utilise a first class lever system although extension (straightening) at the elbow is one example.

- Extension at the elbow can be seen during a throwing action or tennis stroke.
- In Javelin throw the triceps are the effort, the fulcrum is the elbow joint and the load is the weight of the arm and Javelin. There are sometimes more than one lever system operating at joint and the elbow joint is one example.

During extension of the elbow, the effort is created by the triceps via its point of insertion on the ulna, so is a first class lever system.

- First-class leverage also occurs when you lift your head off your chest.
- A tactically held V-sit up position.
- Seated Dumbbell triceps expansion: In this exercise the elbow joint can be considered as axis or fulcrum. The dumbbell acts as the load and the triceps muscles provide the force acts as effort.
- Flexion and extension of the hinge joint is the example of first class lever.
- Throwing a ball from the back of the head.

However, during flexion at the elbow, as in a bicep curl, the effort comes from the point of insertion of the biceps on the radius; this is an example of a third class lever system.

Function of First Class Lever:

First class lever systems can increase both the effects of effort and the speed of body.

Second Class Lever System:

The second class levers consist of a system where both load and the effort are placed on the same side of the fulcrum but applied in opposite directions. Load lies between the effort and the fulcrum. Even this type of levers, the is magnified with the effort being lighter than the load.

The load is situated between the fulcrum and the force. Therefore the force lever arm would always be greater than the load lever arm. Classic examples of second class lever are a wheelbarrow, push-up exercise, or nutcracker. In this type of lever movement of the fulcurm will increase or decrease both the force arm and the resistance arm. The force arm always the longer of the two, and therefore the force needed to lift resisting weight will always be less than weight.

This type of lever class commonly occurs in the body when gravity, an external force, and or inertia are the effort force and muscles are the resistance (load). In this situation the muscle is contracting eccentrically against the force.

Example in Sports Activities:

1. Exercises involving plantar flexion at the ankle (going up on your toes) are second class lever systems, such as a calf raise or when jumping upwards whilst performing a layup in basketball.
2. Standing on tip toes is a second class lever. The fulcrum /pivot is at your toe or ball of the foot, joints and your foot acts as a lever arm. Your calf muscles and Achilles tendon provide the effort when the calf muscle contracts. The load is your body weight and is lifted by the effort (muscle contract).
3. Exercises involving plantar flexion at the ankle (going up on your toes) are second class lever systems, such as a calf raise or when jumping upwards whilst performing a layup in basketball.

4. In the example of plantar flexion at the ankle joint, the ball of the foot and toes are the fulcrum, the weight of the body is the load and the effort is applied by the gastrocnemius muscle.
5. Straight push-ups; The foot is the axis of rotation when reaction force of ground pushing against hand shifts weight of the body's center of gravity. The reaction force acts as the effort and the body weight as the load.

Function of Second Class Lever:

Second class lever systems only tend to increase the effect of the effort force, in other words, are effective at overcoming a resistance as opposed to generating speed.

Third Class Lever System:

In a third class lever system, the force/effort is the middle component and lies between the fulcrum and load/ resistance. In this type of lever the force arm is always shorter than the resistance arm and so a large amount of must be applied, but the resistance is moved through a much longer range of motion that of the force application.

In Human Body

Levers can be found either internally in the human body in the form of bones (limbs) or externally in the form of sports equipment/ implements such as rackets, bats, poles, hockey sticks and so on. There are three types of lever system are found in the body; each is determined by the relevant three positions

In the majority of movements in the human body are classified as third class lever systems.

Most skeletal muscles of the body act in third-class lever systems. This is particularly important in the motions of the limbs, because the result desired are very often those of speed or range of motion, albeit at the expense of force.

An example is the activity of the biceps muscle of the arm;

1- A bent arm is a third Class lever. The pivot is at the elbow and the forearm acts as the lever arm. 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. Third-class lever systems permit a muscle to be inserted very close to the joint across which movement occurs, which allows rapid, extensive movements (as in throwing) with relatively little shortening of the muscle. Muscles involved in third-class levers tend to be thicker and more powerful.
2- There are many examples of third class lever systems, including both flexion and extension at the elbow and knee joint. These movements are involved in running, jumping and kicking.
3- During flexion movement at the knee, the point of insertion of the hamstrings on the tibia is the effort, the knee joint is the fulcrum and the weight of the leg is the load.

Example in Sports Activities:

- Sit up
- Bicep Curl

Function of Third class lever:

Third class lever systems are used to increase the speed of a body and allow a wide range of movement.

In conclusion, differences in the positioning of the three elements modify muscle activity with respect to speed of contraction, range of movement, and the weight of the load that can be lifted.

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Question: - 6-Define and various types of motion in sports.

Motion:

Motion is one of the key topics in physics. Everything in the universe moves. It might only be a small amount of movement and very slow, but movement does happen. Don't forget that even if you appear to be standing still, the Earth is moving around the Sun, and the Sun is moving around our galaxy. The movement never stops.It's hard to believe, but everything in the world is in motion, all the time. There are many things around us. Some are in motion and some are not. When we think of motion we often think of cars, bicycles, kids running, basketballs bouncing and airplanes flying. But motion is so much more. Motion is important to our lives and impacts so many things that we do. .

Motion is the act of moving and plays a huge role in the study of physics. This lesson walks through important terms and the laws of motion that guide the study of motion. Motion is one part of what physicists call mechanics. Over the years, scientists have discovered several rules or laws that explain motion and the causes of changes in motion.

Meaning and Definition of Motion

Motion is a movement that results from a force. In any physical activity, there are multiple forces and motions occurring. This could include angular motion around a joint or the motion of the whole body in various directions. The motion or movements of the body are often caused by forces produced by our muscles, but this is not always the case.

For example:

If an opposition player pushes you to the ground, the force has come from them, and not your own muscles.

Definition:-

1-Motion is continuous change of position

2-Motion is the process of something moving or changing place, or even just changing position.

3-Motion is created and modified by the actions of forces (mostly muscle forces, but also by external forces from the environment).

As long as force is applied, motion will take place e.g. as long as the athlete is running motion takes place.

There are a lot of factors involved every time something moves. There are fewer factors involved if an object moves at the same speed in a straight line. However, most movement involves changing the speed of the movement and changing directions.

Examples of motion include:

Running, Cycling, Jumping, Swimming, Eating, Drinking, Playing, Writing, Typing, Moving Cars, Throwing Ball etc.

Types of Motion

The type of motion is determined by the direction of movement. The only type of motion you are asked to understand is linear motion. However, in order to properly apply velocity, speed, acceleration, and momentum the other types of motion should also be defined.

General Motion:

General motion is the most common type of motion in sport and physical exercise. General motion is a combination of linear and angular motion. Running and walking are among typical examples. In this case the trunk moves in linear motion as a result of rotary motions of individual segments of extremities.

Example: Running, walking and Riding a bicycle is another example of general motion. There are two basic types of motion. These come into play in combination when applying mechanical principles to sport skills:

Linear Motion:

Linear motion occurs when an object or person travels in a straight line, as when sledding across a level surface.

Examples: In the 100mt. race the body of sprinter is moving forward in a straight line but the arms and legs is moving in a circular motion. Running Walking and bowling in sports activities etc.

Angular Motion

Angular motion motion occurs when an object or person turns about a center point, axis, or fulcrum and does not travel from place to place. It is common in diving and gymnastic skills hammer throws and disco put discuss throw. When athletes rotate, twist, or spin. It is further classified into 2 type's i.e. internal axis and External axis.

Internal Axis-

If the axis of the rotating body lies inside the human body then it is considered as an internal axis. Such as games such as thrower's action swinging hammer throw etc.

External Axis-

If the axis of the rotating body lies outside the human body then it is termed as an external axis. For example: - Giant wheel, Giant swing by gymnast on horizontal bar, moving ceiling fan etc**.**

Rectilinear Motion –

This is a motion is movement where objects move along a straight line.

Examples: March past of athletes, sprinters running 100mt race from start to finish, falling stones from a height etc.

Circular Motion –

This is a motion where objects move along a circular path or movement around the axis of rotation. A type of circular motion where an object spins on its own axis, it is called rotational or circular motion.

Example: Rolling ball in bowling game, figure skaters spin on their toes and the arms and leg of sprinter is moving in circular movements while moving forward etc.,

Uniform Motion:

It is a motion in which speed unchanged means motion is steady, constant with unchanged speed.

Examples: A long distance runner will try to run economically in an attempt to maintain the pace of running (uniform motion) as long as possible.

Projectile Motion

Projectile motion is a form of motion experienced by an object or particle (a projectile) that is thrown near the Earth's surface and moves along a curved path under the action of gravity only and its path is called its trajectory.

For example, a basketball is thrown towards the basket, a ball thrown by fielder towards baller, throwing a hammer, discuss throw etc. In all these cases objects are considered as the projectile. Trajectory is the path covered by the projectile until it stops.

Note: In projectile motion the center of gravity will follow a parabolic path.

Factors affecting projectile trajectory

Propelling Force:

The propelling force produces certain effects depending upon its point and direction of application. If the application is directly through the projectile's center of gravity, only linear motion results from the force. As the projecting force is moved further from the center of gravity, rotator motion of the object increases at the expense of linear motion. If the force is below the object's center of gravity, back spin is results. Forward spin results when the force is above the center of gravity. When the force is off center to the left, clockwise spin results and when it is off center to right, counter clockwise spin occurs.

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Question: 7- Explain the meaning, definition, types and factors responsible for Equilibrium.

When we say some-thing is stable or balance, we generally mean that it is not easily upset. So we can say that it takes some effort to topple it. By contrast, of course, an unstable objet is one that is easily upset.

Definition of equilibrium

It is defined as a state of balance or a stable among the forces acting within or upon a body. It is a state that there is no acceleration of body.

A body or object is said to be in equilibrium, when

1- The sum of the forces acting on it is equal to zero

2- The sum of the torques acting on it is equal to zero.

In other words, there are no imbalancing forces or torques.

Activities equilibrium is called as balance, poise, position or stability the body movement of kind

any involves some aspect of equilibrium

Example:

Sitting, Standing, Walking and Running.

Types of Equilibrium:

There are three types of equilibrium

1. Static equilibrium.
2. Dynamic equilibrium.
3. Neutral equilibrium.

•Static Equilibrium

Static equilibrium is a condition in which sum of forces acting within or upon a body. It is state of no acceleration of body.

When a body is at rest or completely motionless. 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.

• Dynamic equilibrium

"Dynamic stability or equilibrium is balance during movement."

Dynamic stability or equilibrium is balancing the body during movement. When the sum of the forces and sum of the movements are zero and the body is in state in motion. It frequently happens that the line of gravity of an athlete will fall outside the base of support for movement.

For example,

1. 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.
2. In the 100m race when an athlete is about to start and is in the sitting position he acquires an unstable position so he breaks inertia of rest quickly.
3. Same is in the swimming, where the swimmer makes his body unstable using block.
4. A man carrying heavy bucket in his right hand leans towards his left hand side to maintain equilibrium.
5. While climbing up a hill the climber bend forward so that he does not fall. The equilibrium is maintained by bringing the Center of Gravity down.

Neutral Equilibrium

This is third category of equilibrium in which an object is in neutral position or equilibrium. In this state the height of the center of gravity is unaffected by a push, as in case of ball lying on the ground is said to be in neutral equilibrium

Factors Responsible for Stability/Equilibrium

Following factors responsible for the Equilibrium

1. **Stability is directly proportional to the area of the base on which the body rests.**

Stability depends upon area of the base. n Is the base increases, the stability increases and vice-versa.

Example:

- A person standing on toes has - very less degree of stability unstable.
- Both feet together - little more.
- Both feet apart - further more.
- The person with both hands and feet on the ground (four point football stance) - much more.
- Wrestler's defensive down position - still more.
- A person lying on the floor with the arms and feet spread- very high.

2. **Stability is indirectly proportional to the distance of the center of gravity of the body above the base.**

As the height of the center of gravity (C.G) increases the stability decreases and vice-versa. The centre of gravity of a body is the point from which the body can have perfect balance, It can be considered as the centre of weight of the body. Normally in an adult man the C.G. in a standing position will be at 56.18 % of the height from the ground and it will be at 55.14 % in adult women.

Example:

If standing person raises his hands upwards, the C.G. will move high and stability decreases.

3. **For equilibrium to exist the center of gravity must fall within its base.**

The stability will be more when the C.G. falls within the base of the body, or object a gymnast in performing the hand stand should keep his body vertical so that C.G. falls between his hands and has more stability

Example:

In the low crouch in basketball dribbling the C.G. drops within the base it creates wider base and closer to the ground. Hence, the stability will be more

4. **Equilibrium is directly proportional to the horizontal distance of the center of gravity to the edge of the base in a given direction of movement**

When an athlete is your marks position the C.G. falls at the centre of the and when he acquires the 'set' position his C.G. will be moved toward the direction of the movement and the horizontal distance from the edge of the movement is direction and the stability is also decreases.

A basketball rapidly, leans backward and brings the C.G. away from the direction of movement.

Example:

When a person bends or leans towards the direction of movement, his stability will be less.

5. **Equilibrium is directly proportional to the weight of the base.**

Example:

The heavy body will have more stability. If two individuals of different weights are standing, it is difficult to more the equilibrium of heavier person.

6. **Physiological and other factors responsible for equilibrium**

Physiological factors:

Factors related to both dynamic and static stability are comes under physiological factor such as:

1. Kinesthetic sense
2. Co-ordination
3. Inner-ear balance

4. Other factors

1. Experience of the sportsmen
2. Familiarity with the surface condition of their sports
3. Condition of footwear.

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Question:8 - Explain the meaning, definition, condition (Static and Dynamic Equilibrium) and principles of Equilibrium.

When we say some-thing is stable or balance, we generally mean that it is not easily upset. So we can say that it takes some effort to topple it. By contrast, of course, an unstable objet is one that is easily upset.

Definition of equilibrium

It is defined as a state of balance or a stable among the forces acting within or upon a body. It is a state that there is no acceleration of body.

A body or object is said to be in equilibrium, when

1- The sum of the forces acting on it is equal to zero

2- The sum of the torques acting on it is equal to zero.

In other words, there are no misbalancing forces or torques.

Activities equilibrium is called as balance, poise, position or stability the body movement of kind

any involves some aspect of equilibrium

Example:

Sitting, Standing, Walking and Running.

Conditions of Static and Dynamic Equilibrium

Conditions of Static Equilibrium

1. A person has balance when the center of gravity falls within the base of support
2. A person has balance in the direct proportion to the size of the base. The larger the base of support, the more balance

3. A person has balance depending on the body weight (mass). The greater the weight, the more balance

4. A person has balance, depending on the height of the center of gravity. The lower the center of gravity, the more balance

5. A person has balance, depending on where the center of gravity is in relation to the base of support. Balance is less if the center of gravity is near the edge of the base. When anticipating an oncoming force, stability may be improved by placing the center of gravity nearer the side of the base of support expected to receive the force

6. In anticipation of an oncoming force, stability may be increased by enlarging the size of the base of support in the direction of the anticipated force.

7. Equilibrium may be enhanced by increasing the friction between the body & the surfaces it contacts

8. Rotation about an axis aids balance. a moving bike is easier to balance than a stationary bike

Conditions of Dynamic equilibrium

1. In walking a person throws the body in and out of balance with each step

2. In rapid running movements where moving inertia is high, the center of gravity has to be lowered to maintain balance when stopping or changing direction

3. In jumping activities the center of gravity needs to be raised as high as possible

4. Opposite limbs movements- also counter react the loss of equilibrium during directional changes.

5. The dynamic equilibrium depends to a greater extent on physiological factor – concern with the maintenance of posture and equilibrium especially.

6. To maintain dynamic equilibrium, the required amount of friction from the base is essential and it is related to the coefficient of friction.

The Principle of the equilibrium

Following principle are kept in mind for maintaining better equilibrium:

Principle 1

An Athlete increases their stability when their Line of Gravity is centralized within their base of support.

Principle 2

An athlete increases their stability when they increase size of their Base of Support.

Principle 3

An athlete increases their stability when the lower the height of their Centre of Gravity

Principle 4

An athlete increases their stability when they extend their base,Line of Gravity in the direction of an oncoming force.

Principle 5

An athlete increase stability by increasing mass.

Principle 6

An increase in Friction can improve an athlete's Stability

Principle 7

Rotation can improve an athlete's Stability

Principle 8

Shifting the line of gravity toward oncoming forces can improve stability

****

Question: 9 - Explain the meaning, definition, types and importance of forces in physical education and sports.

Meaning of Force:

Push or pull of an object is considered a force. Push and pull come from the objects interacting with one another. Terms like stretch and squeeze can also be used to denote force. In Physics, force is defined as:

The push or pull on an object with mass that causes it to change its velocity.

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.

Force is an external agent capable of changing the state of rest or motion of a particular body. It has a magnitude and a direction. The direction towards which the force is applied is known as the direction of the force and the application of force is the point where force is applied.

Types of Force

1. Centripetal force
2. Centrifugal force
3. Gravitational force
4. Frictional force
5. Static force

Importance and application of force in Physical education Sports

1. Helps to move
2. Stops the moving object
3. Helps to accelerate
4. Helps in throwing object.
5. Helps to lift the object.
6. Helps to pull the object

****

Question: 10- Explain meaning definition, types and application Force in sports activities

Meaning of Force:

Mechanics is basically the study of the motion of physical bodies and the understanding of the forces that cause the motion. It is therefore important to understand the different types of forces which commonly occur in mechanics.

Push or pull of an object is considered a force. Push and pull come from the objects interacting with one another. Terms like stretch and squeeze can also be used to denote force. *In Physics, force is defined as:*

The push or pull on an object with mass that causes it to change its velocity.

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.

Force is an external agent capable of changing the state of rest or motion of a particular body. It has a magnitude and a direction. The direction towards which the force is applied is known as the direction of the force and the application of force is the point where force is applied.

Types of Force

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2. Stops the moving object
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Question: 11- Explain meaning definition and roll of Center of Gravity in sports.

In this world every item has a center of gravity. Every person has a center of gravity as well. Simply put, the center of gravity is the determining factor in balance. If the center of gravity is in balance, then so is the object. However, if the center of gravity is thrown off balance then the object will either be supported or will topple.

Definition of Center of Gravity:

- The center of gravity of an object is the point at which weight is evenly dispersed and all sides are in balance.
- The center of gravity is the point at which all the weight or mass of the body can be considered to be concentrated.
- The Center of Gravity is an imaginary point around which body weight is evenly distribute or centered.

In another words we say that where the total weight or mass of the body works and the body moves around the point irrespective of the state (Shape) of the body, but in many other objects, it's at a fixed location.

For Example: Solid masses of uniform density- Example: Shot and discus, the location of the center point, often called the mass center, is at the geometric centers and remains constant. But in the human body the center of gravity will be determined by the position of the body. In the rings or hoops, the center of gravity it found in air space at the center of the circle.

Roll of Center of Gravity in Sports:

Every single body and thus the athletes themselves, is made up of individual components each of which has its own weight. So our weight is just the sum of individual weights, of components such as our arms, legs, etc. The point, about which the distribution of these individual weights is symmetrical, is the center of gravity of the body. Thus, if a body has more mass distributed in its upper part, the center of gravity will be closer to the top of the body. This applies to humans, as the center of gravity of an average person is located approximately at a height of one meter, thus being above the waist.

There are two properties of the center of gravity that have a great impact on sports activity. First of all its location is dependent on the shape of the body. So if the same body is to take a different shape, the position of the center of gravity will shift or change.

In the above figure, an athlete that bends his/her legs will lower his/her center of gravity position. This, amongst other things, will result in greater stability, something especially important in sports such as wrestling.

Also, and this may sound the strangest, the center of gravity can lie entirely outside the body itself. For example, if the body is hollow it will literally be positioned somewhere in the air.

During the Olympic Games in Mexico, in 1968, an, until then unknown athlete, the American Dick Fosbury, came from nowhere to teach the world about both of these properties.

The truly ingenious leap in the technique was that by clearing the bar with his back and by changing the shape of his body, the athlete could clear the bar without his center of gravity having to also clear it. By this change in body shape he was able to move his center of gravity outside his body. The energy required for a jump depends on the maximum height of the center of gravity and so by lowering its position one also lowers the energy required to clear the bar. As far as so many examples of Center of Gravity in sports activities such as:

1. A sport is wrestling, the lower center gravity and wider stance increases stability.
2. Newton's 1st law of motion: An example is pole vaulting; the body is in motion until you reach the ground, which is the outside force.
3. Newton's 2nd law of motion: An example of this could be when a soccer player applies force to the ball with a low mass when kicking it, it causes the ball to accelerate.
4. Newton's 3rd law of motion: An example is a diver, when the diver pushes off the board, there is an equal and opposite reaction of the diver jumping up into the air.
5. Conservation of energy: An example is tennis, the energy given from the racket is transferred to the tennis ball

Above examples there is so many example of center of gravity in sports activities i.e. swimming, diving, gymnastic events and athletics like other sports activities etc. are concerned, an understanding of the role played by the center of gravity in sports is important.

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Question: 12 – Define Meaning, Types and Importance and advantage of good and poor posture.

Meaning of Posture

Posture is the position in which you hold your body upright against gravity while standing, sitting or lying down. The way you carry your body when you stand, sit, walk or work is very important. This is because it can affect your health, appearance and ease with which you do your work. It is therefore very importance that you carry yourself properly.

Good Posture

Posture means keeping the natural balance of the body aligned. It is the way the body parts are held up or carried when you walk, stand, sit or work. In good posture, the back is kept straight, shoulders pull well back and head held high. A good posture can be developed by any healthy person. It requires determination and practice.

Keeping the Body Parts Aligned and Good Posture

There are three major weight centers in the body: head, chest and waist or pelvis. Good posture involves keeping the major weight centers aligned and balanced on each other, whether you are sitting, standing or walking. When an imbalance occurs, it is the result of poor posture.

Importance of Good Posture

1. Good posture enhances appearance.
2. It helps different parts of the body to be supported by the right bones and muscles.
3. It gives the body a comfortable and relaxed feeling.
4. It affects the way your clothes fit you. Clothes fit better with good posture.
5. It promotes good health.
6. Good posture gives dignity, poise, self-confidence and respect.
7. It can improve a person's movement and activities.
8. It prevents body pains.

9. Poor posture can also be considered a sign to poor nutrition.

Disadvantages 0f Poor Posture

Poor posture in siting, standing or walking has the following disadvantages:

1. Muscles of the body do extra work in effort to keep the body balanced. This could be painful.
2. Some organs of the body may be thrown off their natural position. This can result in backache, tiredness, constipation and headache.
3. It can also affect the functioning body organs.
4. It causes waste of energy as muscles do extra work to keep body parts aligned.
5. Poor posture can also be considered a sign of poor nutrition.
6. It results in ill-fitted clothes.
7. It can make a person look sluggish.

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Question: 13- Define with example and difference the term Distance and displacement.

Distance and Displacement:

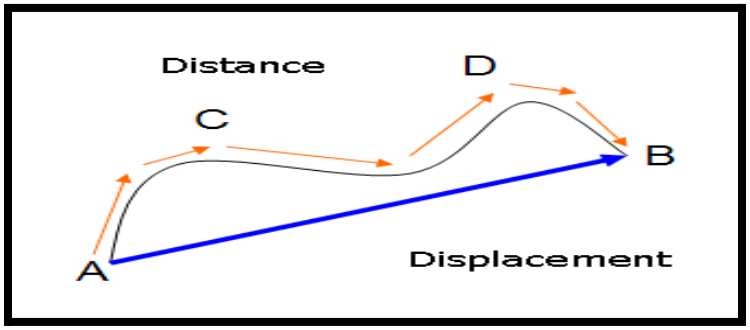
Distance and displacement are two quantities that may seem to mean the same thing yet have distinctly different definitions and meanings. But both distance and displacement are measured in meters (m).

Distance:

The length covered by a moving object at a given time is called distance**.** Distance is a scalar quantity that refers to "how much ground an object has covered" during its motion.

(In below picture point, A and B having a distance 100m). The distance the Yacht has covered is more than 100m because it has had to zig zag through a longer path A, C, D and B. Distance has only magnitude, so it is scalar quantity.

C.G.S and S.I unit of distance are centimetre and metre respectively.



Displacement:

The change of position of a moving body in a particular direction is called its displacement. Displacement is how far a body has moved. It is the shortest distance between the starting point and the finishing point (Shown in picture in belowpoint A and B).

For example (In below picture point A and B having a distance 100m). From point A, a sailing Yacht might zig zag (tack) backwards and fowards in order to sail 100m east. The displacement of the Yacht is 100m.

The magnitude of the displacement is the linear distance between the initial position and final position of the body. Since displacement has both direction and magnitude, it is a vector quantity.

C.G.S and S.I unit of displacement are centimetre (cm) and metre (m) respectively.

Form the picture and table given below the term Distance and Displacement is clear:

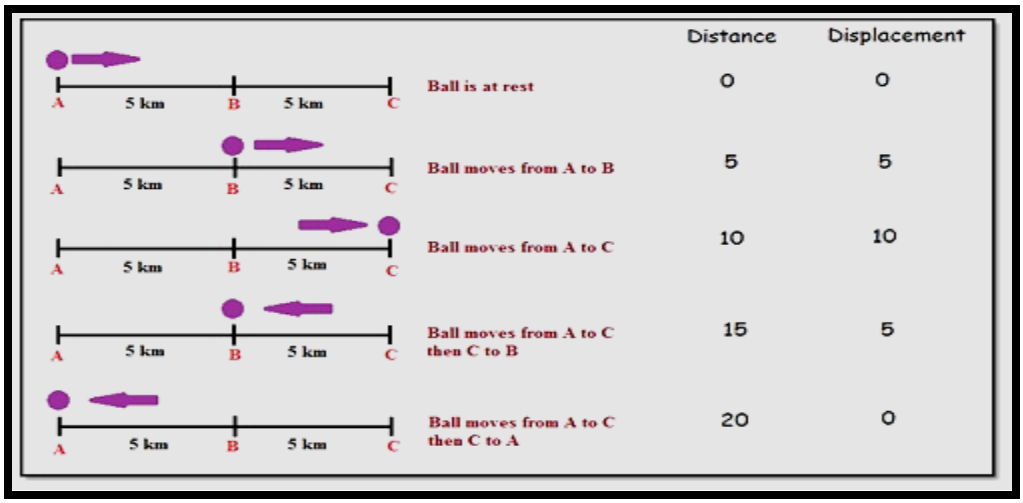


Table:

Stage	Discription	Distance	Displacement
1	Motorcyclist place on point A at this time motorcyclist is in rest position	Zero	Zero km
2	Motorcyclist moves from point A to B	5km	5km
3	Motorcyclist moves from point A to C	10km	10km
4	Motorcyclist moves from point A to C than C to B	15km	5km
5	Motorcyclist moves from point A to C than C to A	20km	Zero km

More examples of distance and displacement:

1- In marathon race runner has run a distance of approximately 26 miles 385 yards. Is displacement the same? Probably it is not unless the course is one very straight line.

2- In 400m race the distance travelled by the sprinter is 400m, but the displacement is practically zero as they finish in the same place from where they started.

What is the difference between distance and displacement?

S.No	Distance	Displacement
1	It is a scalar quantity.	It is a vector quantity.
2	Distance can only be positive.	Displacement at any interval time may be zero, positive or negative. It is possible to have an average displacement equal to zero if the object starts and ends in the same position.
3	Distance is the length of the path travelled by a body in certain interval of time	Displacement is the shortest distance between the initial and final positions of a body.
4	Distance has only magnitude.	Displacement has both magnitude and direction

****

Question: Define Centripetal and Centrifugal force and their application in physical education and sports. Also the differences between Centripetal And Centrifugal Force.

Centripetal Force:

Centripetal force is defined as, “The component of force acting on a body in curvilinear motion that is directed toward the center of curvature or axis of rotation,” In simple words Centripetal force is defined as the force required keeping a body moving in a circular path and directed towards the centre of a circle.

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.

It is a force that produces acceleration and the change of direction from liner to circular. The force acts on the object in inward direction along the radius towards the centre.

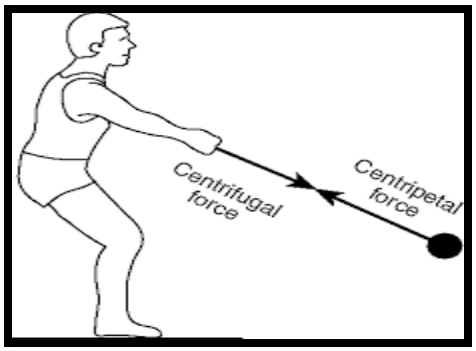
Example:

- When a player swings a bat, he applies centripetal force to make that bat follow the arc of swing.
- When spinning a ball on a string or twirling a lasso, the force of tension on the rope pulls the object towards the centre.
- The centripetal force is provided by the frictional force between the ground and the wheels when turning a car.
- When going through a loop on a roller coaster, the force is provided by the normal force as the seat or wall pushes you towards the centre.
- For the planets orbiting around the Sun, the centripetal force is provided by Gravity.

Centrifugal Force

Centrifugal force is a pseudo force in a circular motion which acts along the radius and is directed away from the centre of the circle.

Centrifugal force is defined as, “The apparent force, equal and opposite to the centripetal force, drawing a rotating body away from the center.



Example:

Centrifugal Force acts on every object moving in a circular path when viewed from a rotating frame of reference. Some examples of Centrifugal Force are given below.

Best example of Centrifugal and Centripetal force both are is seen in Hammer throw shown in image given under: String is held tightly with the help of handle by the thrower’s hands to keep the hammer in circular path before release. There is centripetal force acting upon the hammer pulling inward and there is centrifugal force acting outward on the thrower’s hand force.

- Weight of an object at the poles and on the equator
- A bike making a turn.
- Vehicle driving around a curve
- Equatorial railway

Application of Centripetal and centrifugal force in sports:

Centripetal and centrifugal force have innumerable application in sports like,

1-In game of cricket, 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.

2- In races these forces act when a runner takes a sharp bend leans inward to obtain the necessary centripetal force.

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

Differences Between Centripetal And Centrifugal Force Centripetal force is directed towards the axis of rotation or centre of curvature, and centrifugal force is directed away from the centre of the circle.	
Centripetal Force	**Centrifugal Force**
Centripetal force is the component of force acting on an object in curvilinear motion which is directed towards the axis of rotation or centre of curvature.	Centrifugal force is a pseudo force in a circular motion which acts along the radius and is directed away from the centre of the circle.
It is observed from an inertial frame of reference.	It is observed from a non-inertial frame of reference.
If a car is travelling through a curve on a circular horizontal road, the centripetal force provided by the force of friction between the tyres of the vehicle and the road surface allows the car to negotiate the turn.	When a car in motion takes a sudden turn towards the left, passengers in a car experience an outward push. This is due to the centrifugal force acting on passengers.

****

Question: What is force? Explain in detail about the type of forces.

What is Force?

. In simple terms, it is a push or a pull on an object that takes place when two objects interact. It is the basic cause of motion from rest.

Definitions for Force:

"Force is anything which produces motion or changes motion."

"Force can be defined as a push or a pull that changes or tends to change the state of rest or uniform motion of an object or changes the direction or shape of an object. It causes objects to accelerate or add to their overall pressure"

Force is a push or pull

Anybody can't see the force, but forces make the world go round.

For instance, force has been defined as an interaction that changes the motion of an object if unopposed. When this statement is examined closely, we see the role of push-pull in this. A force that changes the direction of an object towards you, it would be a pull. On the other hand, if it moves away, it is a push. Sometimes, force is simply defined as a push or pull upon an object resulting from the object's interaction with another object. Hence, any kind of force is basically a push or a pull.

Push: Applied force intended to drive.

Pull: Action which acts in direction of the origin of force.

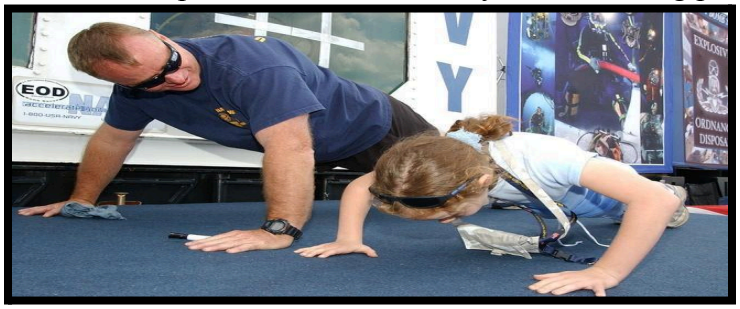
So based on above definition, we will try grouping all the actions into namely two categories:

Push

Ge nerally, Forces are described as push or pull on an object.



On the above picture shows an activity demonstrating pull action (pulling the rope).



Pull.

In this picture shows an activity demonstrating a push action (pushing the ground so as to lift the body).

1. Force is the capacity to do work or cause physical change.

Example:

When the player kicks the ball, kicks changes its speed from zero to a non-zero value thus changing the state of motion of the ball. Similar situation can be thought when a player kicks a moving ball in the game (increasing the speed of moving object)

2. Force= Mass times acceleration (F = ma)

Example:

Newton's second law is often stated as F=ma, which means 'F' acting on an object is equal to the mass (m) of an object times its acceleration (a). Therefore, the more mass an object has the more 'F' you need to accelerate it. And the greater the F is, the greater is the object's acceleration.

3. A force is that which changes or tends to change the state of rest or motion of a body.

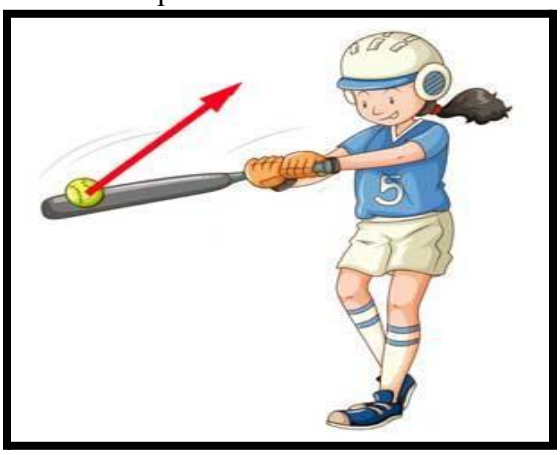
Example:

State of motion of is described by direction of motion and speed of the object. Even if the speed of object is zero it is to be considered in state of motion which is referred to as state of rest. State of motion of an object cannot change until and unless some force acts on the object.

On above definitions it is most simply defined as a directed push or pull by one body acting upon another. Because it has both magnitude and direction, all changes in motion are due to some force action, but not all force actions result in changes motion of the body acted upon. i.e. pushing a wall will not result is change of its motion. It mens it is necessry for all changes in

motion are due to some force action that there is an unbalanced force, ie. One whose magnitude is greater than the magnitude of the other object that is to be moved.

Here are some examples of forces acting on a baseball player. Force is a vector quantity which means it needs both magnitude (size) and direction. To get a better understanding of the forces acting in a particular situation we can draw arrows to indicate the direction the forces are acting. To do this we need three pieces of information:



The red arrow in the diagram above indicates the point at which the force acts, the direction and the size. If the force was bigger we could use a larger arrow.

1. The point which the force is applied.
2. The direction of the force.
3. The size or magnitude of the force

Difference between Push and Pull:

Push and pull both are forces, but the difference is in their direction at which it is applied. if the force applied in the direction of motion of the particle then we call it as push .

If that force applied in the direction opposite to the motion of particle then it is termed as pull.

Consider a example, a particle is moving along positive x-direction.

Case 1:

If the force is also applied in the positive x-direction on the particle then we are pushing the particle

Case 2:

If the force is applied in the negative x-direction i.e, opposite to the motion of particle then we are pulling the particle

Types of Forces:

In addition to being able to push or pull, an unbalance force may also cause distortion in an object. Force can be labeled as per its effect on the object, as some names of forces are given as under:-

Net Force

The net force is the sum of all the forces acting on a body. If the forces are balanced then the body will not move or change velocity. If the forces are not balanced then the body will move in the direction that the sum of the forces (all of them added up) acts.

Balance and Unbalance Forces

A force is a push or a pull which alters the state of motion of a body and is measured in Newtons (N). As explained in Newton's first law of motion a force is required to make a stationary body move, change speed, direction or stop.

Internal Force

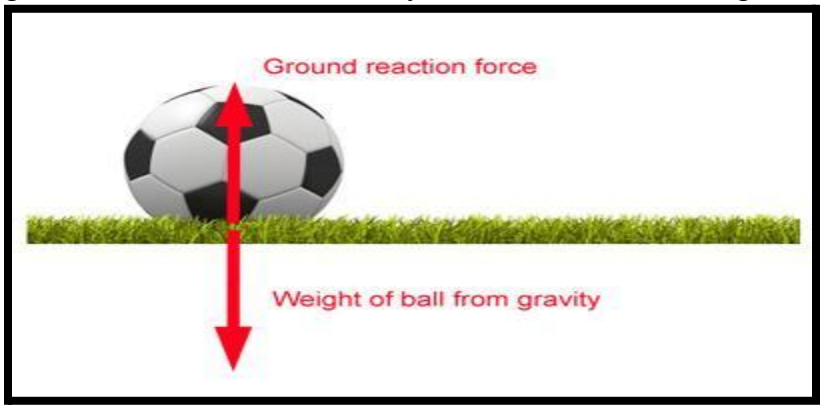
In sport and internal force is one which is generated within the body for example the leg muscles contracting to move the bones.

External Force

An external force is one which acts outside the body for example the boxer's glove as it strikes the head of their opponant.

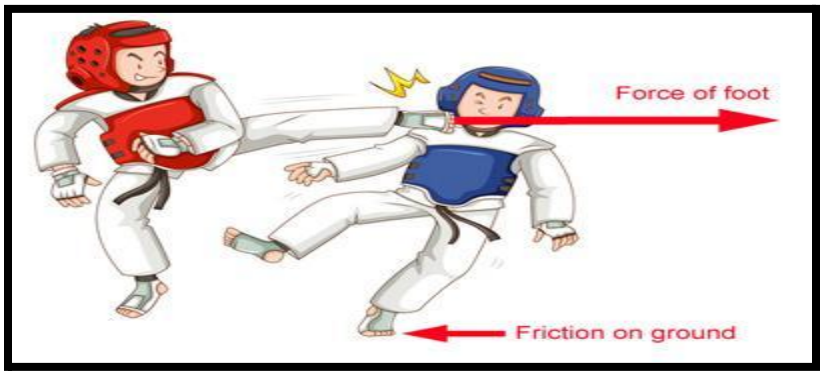
Balance Force

In the diagram below the ball is stationary because the forces acting on it are balanced.



Unbalance Forces

In the diagram below the forces on the blue fighter are not balanced. The force of foot on face is much greater than any resisting forces from the muscles of the blue fighter. Friction forces on the ground prevent the blue player from sliding. Gravity also acts on both fighters.



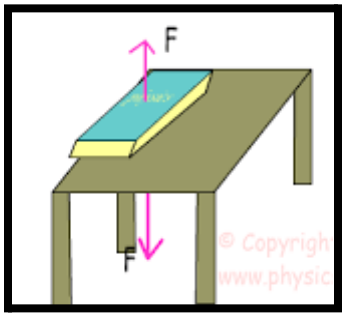
Comparison between Balanced and Unbalanced Forces:

Basis For Comparison	**Balanced Forces**	**Unbalanced forces**
Meaning	When the forces exerted on the object, are of equal size but in opposite direction, then the	When the forces applied on the object are unequal in size, then the forces are known as unbalanced forces.
Magnitude	Equal	Unequal
Direction	Opposite	Same or Opposite

Stationary Object	Stays at rest	Moves in the direction of greater force
Moving Object	Continues to move in the same speed	Changes its speed and direction.
Net force	Zero	Non-Zero

Normal Force:

Contact objects exert force to each other because of their weights.



For Example : Book exerts a force to table because of its weight and table also exerts force to the book. We call this force as "normal force" which is same in magnitude and normal force image opposite in direction with the applied force (weight of the book).



For example: In daily life, when a person stand in anatomical position, Gravity pulls dowandard the person and the floor pushes upward the person. Like this so many example are seen in various sports acivities when an individual in initial position to perfoem any activity of sports.

A Tension Force: (It is the force which tends to stretch an object.)

Tension force is a pulling force that creates tension in the object to which it is applied. A force that is transmitted through a string, rope, cable or wire when it is pulled tightly by the object on the opposite end is a tension force. This force flows across the length of the wire or rope.

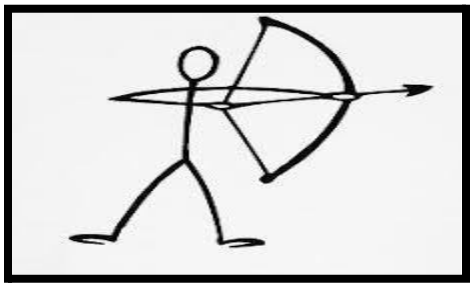
Examples-

1- A cable car or climbing a mountain using a rope.

2- There are many examples in sport, such as the strings of a tennis racquet,



3- The string of an archer's bow.



4- The hammer wire during rotation



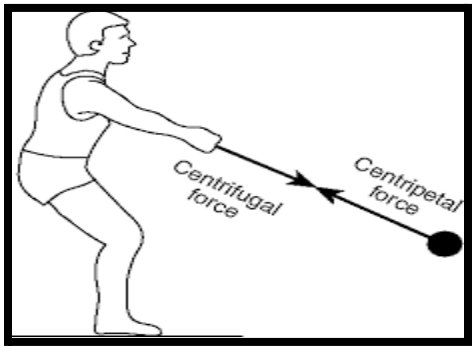
Centripetal Force:

Centripetal force is defined as, "The component of force acting on a body in curvilinear motion that is directed toward the center of curvature or axis of rotation,"

It is a force that produces acceleration and the change of direction from liner to circular. The force acts on the object in inward direction along the radius towards the centre.
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.
Example:
When a player swings a bat, he applies centripetal force to make that bat follow the arc of swing.

Centrifugal Force

Centrifugal force is defined as, "The apparent force, equal and opposite to the centripetal force, drawing a rotating body away from the center.



Example:

Best example of Centrifugal and Centripetal force both are is seen in Hammer throw shown in image given under: String is held tightly with the help of handle by the thrower's hands to keep the hammer in circular path before release. There is centripetal force acting upon the hammer pulling inward and there is centrifugal force acting outward on the thrower's hand force.

Application of Forces in Sports Activities:

1. Friction forces act against the movement of one surface over another such as tennis shoes on a

grass court.

2. Friction is the force which prevents the player slipping and sliding. When air passes over a

surface, particularly at speed then a frictional force called air resistance occurs.

3. Helps to move
4. Stops the moving object
5. Helps to accelerate
6. Helps in throwing object.
7. Helps to lift the object.
8. Helps to pull the object

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Question; 15- What is the meaning and types of balance? How to improve the balance?

Balance is the ability of a player to control their equilibrium or stability (either static or dynamic).

The ability to maintain balance is a key factor in sports such as skiing and windsurfing. Being a motor skill, balance keeps the equilibrium position of resisting the opposing forces, it becomes necessary in all aspects of development and progress in the techniques of skiing and windsurfing.

Learner need to have a good understanding of both static and dynamic balance. Balance is conceived to be a fundamental requirement for athletic performance and everyday activities.

Static Balance –

The ability to control the body, when the body in stationary position. It is the ability to maintain the body in some fixed posture. Static balance is the ability to maintain postural stability and orientation with centre of mass over the base of support and body at rest.

Dynamic Balance –

The ability to control the body, when the body during motion. Defining dynamic postural stability is more challenging. Dynamic balance is the ability to transfer the vertical projection of the centre of gravity around the supporting base of support. Dynamic balance is the ability to maintain postural stability and orientation with centre of mass over the base of support while the body parts are in motion

Example:

In view of coaches and motor performance experts interpret balance as a condition in which a body or object is not linearly or angularly moving. It is stationary. In reference to the human body, if it is not "falling over" it is said to be in balance (e.g., a gymnast maintaining a hand stand).

How to improve the Balance:

Balance is a great skill to help your child progress with their gross motor skill, leisure activities, and activities of daily living. The following activities are various ways you can work

on improving static and dynamic balance for improved performance in activities such as sports, games, self-care, and many more!

1- Stand with one foot on the ground while the other foot is resting on a stool in front of the other foot.

This is the primary skill in working towards balancing on one foot. If this is too easy, replace the stool with a ball that your child has to rest his or her foot on. Then, progress to just standing on one leg. To make it more challenging play a game (such as catch, zoom ball or balloon tennis) while balancing.

2- Stand on top of a bosu ball.

A bosu ball is an exercise ball cut in half with a flat plastic surface on the bottom. If your child gets really good at standing on top of the bosu ball, turn it upside down so that the ball is underneath and he or she is standing on the flat side. Once this is mastered, play catch while standing on the bosu ball

3- Stand on a balance board.

A balance board is a flat surface made of wood or hard plastic that has a rounded or curved underside. This can be a very challenging activity just to stay upright!

4- Simply stand on one foot!

Make this into a contest with the whole family and see who can maintain their balance the longest.The person who wins gets to pick a family activity.

5- Put two lines of tape on the ground and practice walking on a pretend balance beam.

The space between the two pieces of tape could start large (6 inches) and progress to 4 inches apart. If your child steps out of bounds, he or she has to start again. By employing a balance beam that is flush3 with the ground, this will decrease any possible fear of falling. Once this becomes easier, utilize a real balance beam to work on more challenging balance skills.

6- Sit on an exercise ball while playing a board game at the table.

Don't let your child put his or her feet on the ground while playing unless they need to make sure they don't fall.

7- Play hopscotch only while jumping on one foot.

No switching feet is allowed! This makes the game slightly more challenging.

8- Sit, kneel, or stand on a flat platform swing.

Once you child can simply balance, play catch, zoomball, or balloon volleyball while sitting, kneeling, or standing.

9- Stand on a trampoline with just one leg on the surface.

To make this even more challenging, invite someone else to walk on the trampoline (or jump) while trying to keep your balance!

10- Try any of the above activities with your eyes closed.

Balancing with your eyes closed is significantly harder than having your eyes open. Therefore, if your child has mastered all of the above activities, make it one step harder to keep them challenged!

The possibilities are endless! Get creative and make these activities easier or harder depending on your child's progression of skills. By working on balance, your child will learn to use their muscles properly in order to adjust to changes in movement. This will set them up for success in playing games and sports with their peers! As always, ensuring your child's safety during these activities is very important. Utilize pillows, mats, and adult supervision when practicing these activities

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Question; 16- Define in detail the term and fundamental differences between Kinetics and Kinematics

Kinetics and Kinematics

The concepts of physics are applicable in our day to day life. One such concept is Kinetics and Kinematics that deals with motion.

In our day-to-day life, we observe the motion of various objects passing in front of us. Like a moving car, running animals, a ball descending downwards, people ascending to the mountains, flowing rivers. They are in motion and would continue to move, and come at rest whenever they want to.

Physics is all time with us to deal with all such motions, and the study of the motion of these objects in simple terms is called the Mechanics**.**

Kinetics

An arm of science that deals with the efforts (why) of forces upon the motions of material bodies or with changes in a physical or chemical system.

Real-Life Examples of Kinetics

You studied how the enzyme affects the rate of biochemical reactions, torque, friction.

Friction

When a person pushes the ground backwards, the rough surface of the road reacts and exerts a forward force due to friction which causes the motion without friction, the person would have slipped and wouldn't be able to move.

Here, in the above example, kinetics is dealing with the why of motion by considering the static frictional force.

Torque

A little boy switches on the button of the toy, and the toy starts rotating around the bar. Such a type of force that causes the body to rotate about the fixed axis is torque.

Gas kinetics

When the jar containing the gas is put on fire, the elastic collisions start between the molecules, this is due to the production of kinetic energy during the collision, called the Brownian motion. We can say that kinetics is also used in studying thermodynamics.

Other Examples

- Polymerization
- Nanoparticles production
- The process for conversion of synthesis gas to hydrocarbons.
- Combustion
- Catalysis

Kinematics

Throw a ball, what do you see? Surely a motion, isn't it? Kinematics is connected to the motion of any object that exists in the world, starting from the smallest particles to the largest particles in the universe and even the fastest ones, photons.

Had there been no kinematics, no one would know the motion of the earth around the Sun, neither would there be the use of Cannonballs in wars. There would be no such games such as football or cricket if you talk about the real-life experience of kinematics.

The word Kinema means motion.

Suppose you have a wooden block of some weight suppose of 8 kg and you want to see that if this block would move, what would be its position, what time and speed would it take to travel a certain distance, and the path via which it would travel either it is Parabolic, Circular or straight, but not considering why it travelled this or that path or who made that block move?

In simple terms, Kinematics describes 'how the motion is happening and doesn't take into account why the body is moving, and who is setting that body into the motion?

Parameters in Kinematics

- **Displacement** - Movement in a given direction
- **Velocity** - Change in displacement: How fast an object moves in a particular direction
- **Acceleration**: Change in velocity every second
- **Time** - Reference for change through which the above three will be mensurated or measured.

These four variables aid you in describing the motion accurately.

Kinematics Examples

Let's discuss a few examples by different types of motions:

Vertical Motion:

Suppose you throw a stone, and you want to estimate its velocity whether there is any change in velocity or how much change is there, and the time it would take to hit the ground?

We haven't described why that stone is descending, but only the attributes of the motion of that stone.

Horizontal Motion:

Suppose you see a moving object let's say, a car, you would contemplate the attributes such as:

- How much it travelled in meters per second?
- Does the velocity change?
- How much is the change in the velocity?

Projectile Motion:

- Firing a cannonball
- Shooting a basketball

An object such as a cannonball being fired or shooting a basketball at some angle from the horizontal. It will travel some distance up into the air before descending and hitting the ground, we can use a parabola to represent the locus of these objects.

The Fundamental Differences between Kinetics and Kinematics

S.No.	Attributes	Kinetics	Kinematics

1.	Definition	Kinetics is the study of motion considering the mass and external forces as well.	Kinematics is not dependent upon the mass of the object.
2.	Relation	It attempts to determine the relationship between the motion of bodies caused by inertial force and the mass of a body.	Kinematics is about simply describing motion. Such as velocity, displacement, time, and acceleration.
3.	Study	Study of the motion caused by forces, gravity, friction, torque	To determine the "how" of motion.
4.	Nature	It attempts to get at the cause.	It is descriptive and based on observation
5.	Treated	Treated in terms of energy transformations	Treated geometrically
6.	Example	A person sitting inside the train. A child running around in the house, running fan	A Moving Train Parabolic locus traced by a football. A stone hitting the ground.
7.	Uses	Concept of gas laws, fluid dynamics, physical chemistry	Classical mechanics in terms of engineering.

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Question:17- What is projectile ? Explain the factors affecting projectile trajectory.

Or

Write in brief that how angle of projection, height of releas speed of release, gravity and air resistance affect projectile trajectory.

What is projectile?

An object thrown into the space either horizontally or an acute angle under the action of gravity is called a projectile. In simple words, When an object is in flight after being projected or thrown then that object is called a projectile.

Example;- Basketball: The player jumps a little to score a basket and throws the ball in the basket. The motion of the ball is in the form of a projectile.

There are force which act on a projectile-gravitational force and air two resistance. Air resistance of an object varies greatly and it depends on the object's particular shape and the atmospheric conditions in which the object is released.

Projectile - The path followed by a projectile.

Factor affecting Projectile

The following are factor affecting Projectile

Trajectory

Trajectories are mentioned below.

1. Angle of projection:- An object which is projected at different angles covers different distance. When it is projected or released at angle of 25O, making it a parabolic path and coves lesser distance. When it is released at angle of 42O & 45O, makes a parabolic path and covers.

Maximum distance. So the distance covered by an object (Shot Put, Hammer, Javelin, Discus etc. depends on the

2. Projection height relevant to the landing surface:- If the projection height and landing surface are equal the thing should be release/thrown at an angle of 42o to 45o it cover maximum distance. If the level of landing surface is more than projection height the angle shall be increased i.e. should be more than 45o.So thing are cover a maximum distance. If the level of Landing surface is less than projection height the angle of projection should be decreased. I.e. should be less the 45o. The things are cover maximum distance. So the distance of horizontal depends upon the relevancy of projection height and landing surface.

3. Initial velocity:- The distance covered by on object depends on the initial velocity of the projectile. If the initial velocity is more, the object covers maximum distance. And if the initial velocity is less the object covers less distance.

Gravity:-

It is the force of attraction exerted by the earth towards the object's. A Leaner object, if projected will have longer elevation in companion to a light weight object with the same force. Gravity affects a projectile as it decreases the height of the force of gravity acts on the object to stop its upward movement and pulls it back to earth. Limiting vertical component of the projectile.

Air Resistance:-

When a projectile moves through the air, it is slow down by air resistance, Air resistance decrease the h o r i z o n t a l component of projectile. The effect of air resistance is very small but it increase the horizontal component of air resistance acting on a projectile mass surface of the object.

Surface of the object

Surface of the object volume, mass & speed related to the amount of air resistance of a projectile.

Spin:- The amount and direction of spin acting on a projectile will directly affect the distance travelled or covered by a projectile. The main reason behind this fact is the air pressure acting on the object.

- Upper air pressure is maximum on the object.
- Lower air pressure is maximum on the object.