B.P.Ed. - (IV- Semester)
KINESIOLOGY AND BIOMECHANICS

Unit- III

Force – A Mechanical Concepts

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Force

Feeling of force that everyone has but a precise definition can not be built on a “feeling”. To study dynamics we must have a definition of force.

Forces can cause motion, but they are not always correlated with motion. There are hundreds of object around us on which forces are acting, but which are not moving.

Newton stated that

Change of motion is caused by forces.

In other words

Force is ***“something” which can change the state of motion.***

By state of motion we understand parameters defining the motion, that is

Direction

Velocity

Acceleration

- In classical mechanics, the concept of a `force' is based on experimental observations that everything in the universe seems to have a preferred configuration – masses appear to attract each other; objects with opposite charges attract one another; magnets can repel or attract one another.
- The idea of a *force is introduced to quantify the tendency of objects to move towards their preferred* configuration. If objects accelerate very quickly towards their preferred configuration, then we say that there's a big force acting on them. If they don't move (or move at constant velocity), then there is no force. We can't see a force; we can only deduce its existence by observing its effect.
- Specifically, forces are defined through Newton's laws of motion

- A `particle' is a small mass at some position in space.
- When the sum of the forces acting on a particle is zero, its velocity is constant.
- The sum of forces acting on a particle of constant mass is equal to the product of the mass of the particle and its acceleration.
- The forces exerted by two particles on each other are equal in magnitude and opposite in direction.

Definition

The Newtons second law provides the definition of a force – if a mass ***m*** *has acceleration* ***a, the force F*** *acting on it then-*

$$F = m \cdot a$$

❖ Force is a quantitative description of the interaction between two physical bodies, such as an object and its environment. .

❖ Force is an exertion of pressure either focused toward or pulling away from an object, and is applied either by another object or something such as gravity or magnetism.

❖Force is the mass of the object multiplied by its acceleration.

Say, the force upon a free-falling object is its mass multiplied by acceleration due to gravity (9.81 m/s2 or 32.2 ft/s2).

All objects, whether at rest or in motion, have forces acting upon them. Forces are represented by an arrow giving the direction in which the force is being applied and a notation of its strength.

The direction of the force determines the direction in which the object moves or, if the object is static, the direction in which a counter-force is acting.

Unit of force

- In SI units, the standard unit of force is the Newton, given the symbol N.

- The Newton is a derived unit, defined through Newton's second law of motion. According to that a force of 1N causes a 1 kg mass to accelerate at 1 ms−2.

- The fundamental unit of force in the SI convention is kg m/s2

The Effects of Forces

- A force acting on an object may cause the object to change shape, to start moving, to stop moving, to accelerate or decelerate, to pull or Push, to Rebound, to make balance or Unbalance.
- When two objects interact with each other they exert a force on each other, the forces are equal in size but opposite in direction.

Sources of force

Forces may arise from a number of different effects, including

- *Gravity*
- *Electromagnetism or electrostatics*
- *Pressure exerted by fluid or gas on part of a structure*
- *Wind or fluid induced drag or lift forces*
- *Contact forces, which act wherever a structure or component touches anything*
- *Friction forces, which also act at contacts*

Moment of force

Moment of force is the tendency of a force to twist or rotate an object. Motions of our extremities about our joints are caused by moments of force generated by our muscles. Thanks to muscles that produce movents of force in our joints we can move.

For Example of This a gymnast on a horizontal bar will start to rotate only if he produces a relevant moment of force in relation to the horizontal bar. There are three kinds of situations in which an external force acts on a free body.

1. Central force – External force whose vector line goes through the centre of gravity of the body. Central force causes only linear motion. It is a force that acts on a bobsleigh (bobsleigh-a small vehicle with long metal blades under it, built for racing down tracks covered with ice) in the straight part of the tracks.
2. Eccentric Force – external force whose vector line does not go through the centre of gravity of the body. Eccentric force causes changes to both linear and rotary motion. The force acting on a gymnast at a moment of take-off in squat vault over the horse is a good example here.
3. Pair of forces – Forces of identical magnitude but opposite direction, not lying in the same line. Such pairs of forces cause only changes in rotary motion. Resultant of these two forces is zero, therefore according to Newton's first law these forces do not cause a change to linear motion.

Examples of using moment of force in sport

- When paddling in a kayak or a canoe we use a paddle. It is very important to carefully choose the position where we hold the paddle. Holding the paddle in various positions means various moments of force in driving and navigating the boat. As the point of rotation is where we hold the paddle with our top arm, the lower we put our bottom arm the bigger the moment of force is. It practically means that our strokes will be longer but with higher rotating effect of the same force of stroke. For example when we teach beginners to paddle it is necessary to make sure their bottom arm is low enough to enable them to navigate the boat despite using less force.
- In tennis, golf, ice hockey, etc. moment of force depends on the way we hold the racket, golf club, ice hockey stick, etc. The correct grip is a necessity. But the correct grip may vary depending on the needs of a specific athlete in a specific situation. Moment of force must also be used in sports where either the athlete or the equipment he/she uses rotates. In martial arts, such as judo or Greco-Roman wrestling, athletes choose holds to produce highest possible moment of force.

Application Force in sports activities

- All sports involve forces.
- Athletes would not be able to run without the force of friction preventing their feet from slipping.
- In every ball game, a force is applied to the ball to make it move, whether it is from the kick of a footballer or the action of a tennis racket.
- In motor sports, forces help make the vehicles move, and other forces are needed to stop them.
- When a basketball player shoots, it appears as if there is nothing obstructing the ball's path but in reality, there are several external forces acting upon it.
- If these forces were absent, the ball would continue on it's current direction.
- The force of gravity acts upon the ball by pulling it downwards.
- This means the athlete must judge the force of gravity and the weight of the ball and choose the best trajectory so that the ball will sail through the hoop.
- Air resistance is also a factor but is more noticeable in outside

Thank You