

# LEVER,PULLEY AND SPRING

**LEVER:** It is a rigid bar that rotate around on axis - Forces applied to levers will produce either equilibrium or movement such as rotation or translation. –

**There are 3 orders or classes of levers.** - Lever is capable of producing a movement about a fixed point called fulcrum (F). - Work is done when a force or effort (E), applied at one point on the lever, acts upon another force or weight (W), acting at second point on lever. - The perpendicular distance from fulcrum to effort (E) is called as effort arm and from fulcrum to weight (W) is called as weight's arm.

**1st Order Lever:** Here fulcrum is in between the effort and weight; it may be situated centrally, or towards either the effort or the weight, consequently the efforts and the weight arms may be equal, or may exceed the other in length. Ex: Nodding movements of head. Skull represents lever atlanto-occipital joints represents fulcrum, the weight is situated anteriorly in the face and the effort is supplied by contraction of posterior neck muscles.

**2nd Order Lever:** The weight is in between fulcrum and effort, and the effort's arm must therefore always exceed the weight's arm. It helps in taking mechanical advantage, thus known as lever of power. Ex: Rising of heels to stand on toes Tarsal and metatarsal bones are stabilized to form lever. Fulcrum is metatarsophalangeal joints weight of the body is transmitted to ankle joint by talus. Effort is applied by combination of calf muscles.

**3rd Order Lever:** Effort is in between fulcrum and weight, and weight arm must therefore exceed the effort arm. It severs as mechanical disadvantage. It is considered as lever of velocity as it offers more velocity and less stability. Ex: When lever is forearm, fulcrum is elbow joint effort is supplied by contraction of brachialis muscle and weight is some object held in hand.

**EXERCISE THERAPY MECHANICAL ADVANTAGE:** Efficacy of force in relation to lever depends on two factors. They are i) Force exerted (W) or (E) ii) Perpendicular distance from fulcrum to the weight's arm or efforts arm. - When both weights arm and efforts arm are of equal length no advantage is gained. - However if the length of effort arm exceeds weight arm an advantage will be gained by the use of lever. This is known as Mechanical advantage. - Here less effort is required to lift a weight.

Mechanical advantage is obtained in 1st order lever when fulcrum is nearer to weight than to effort, and in all levers of the 2nd order. It is never obtained in 3rd order lever. - It is the ratio of weight to effort  
 $M.A = W/E$

**PULLEYS:** Pulley is a grooved wheel which rotates about a fixed axis by a rope which passes round it. The axis is supported by a frame work or block.

## **Types of pulleys** - i) Fixed pulleys ii) Movable pulleys

- i) **Fixed Pulleys:** These are used to alter the direction of force. The pulley block is fixed and the rope which passes round the wheel is attached to the weight at one end and the effort is applied at the other.
- ii) **Movable pulleys:** These are used to gain mechanical advantage when lifting heavy weights. Commonly used for lifting the trunk for suspension exercises. The upper pulley is fixed to an overhead support, to which one end of rope is attached. The rope is then wound round the movable pulley, to which the weight is attached, and round the fixed pulley, the effort being applied at the free end. MECHANICAL PRINCIPLES 9 Single Fixed Pulley Two Fixed Pulley

**SPRINGS:** Spiral springs are used either to resist or to assist the force of muscular contraction, or to produce passive movement of joint, consist of a uniform coil of wire which is extensible.

**Springs used in parallel:** When a spring of a specific weight is not available two equal springs of half the required weight may be used in parallel to produce the same result.

**Springs used in series:** The weight of two equal springs arranged in series is same as that of a single spring, but the amount by which they must be extended in order to reach the limit of extension is double that required for a single spring.

Book:

Principles of Exercise Therapy (M.Dena Gardiner)

Clayton's Electrotherapy (Forster and Palastanga)