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LEVERS

LEVERS

Lever is a mechanical device to produce turning motion about an axis. Lever is one of the simple machine device for execution of work.

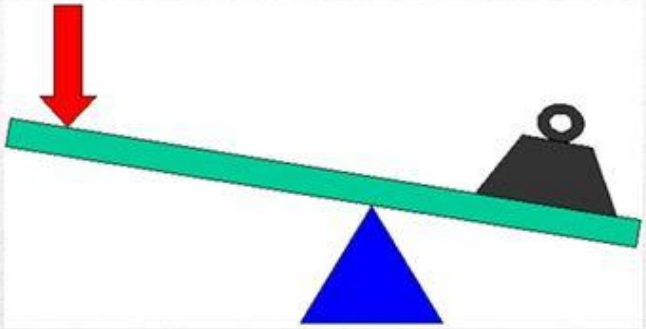
It is a rigid bar moving around a fixed point of axis – force should be applied to move it ,the resistance should be overcome.

Levers

A lever is basically a rigid structure, rotating around a fixed point.

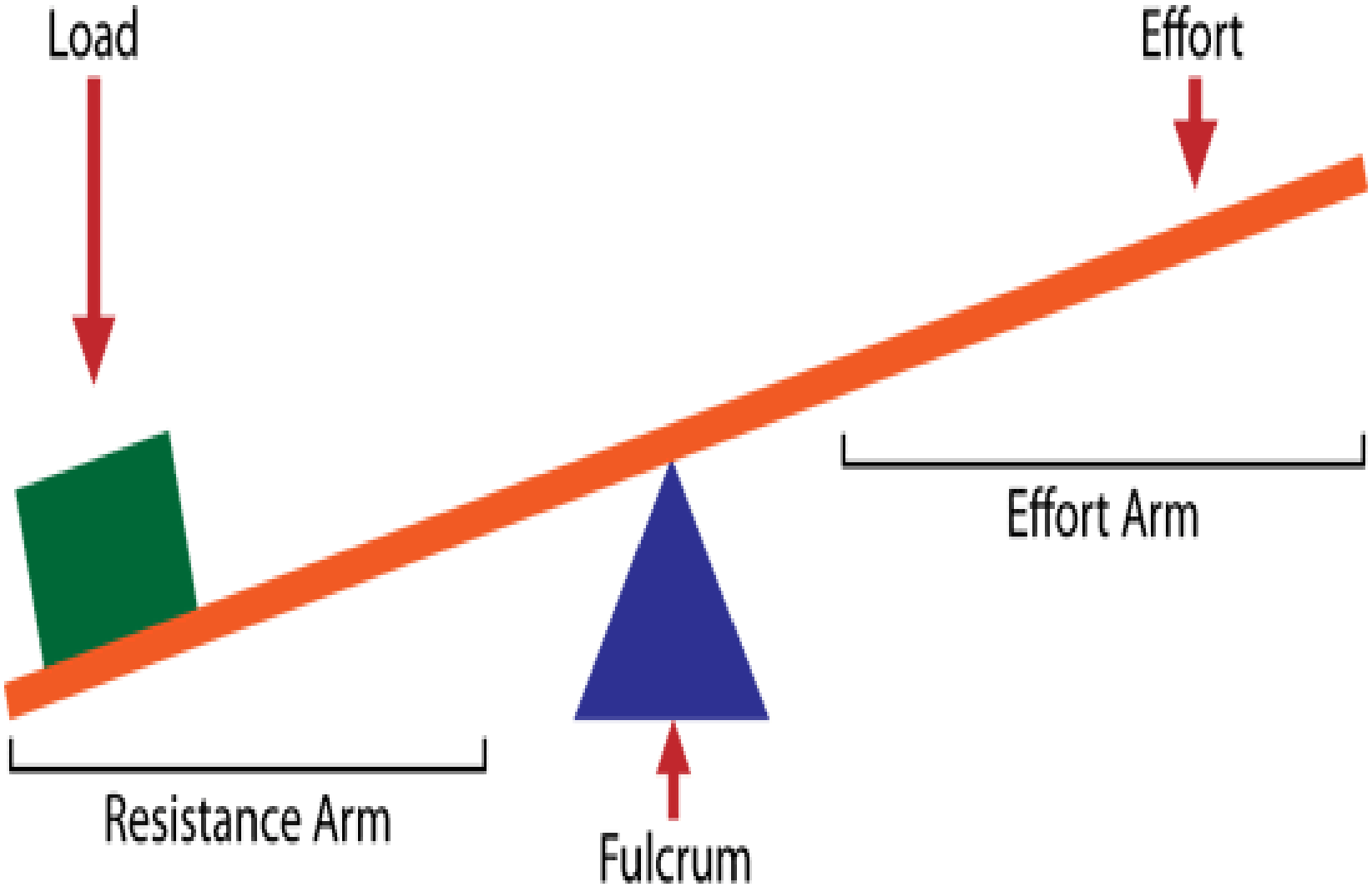
A lever consists of three parts :

- 1. Load (resistance)
- 2. Effort (force)
- 3. Pivot (fulcrum)



List the two main functions of a lever :

- To move greater loads with a set amount of force e.g levering a heavy box with a crowbar
- To help move loads at greater speed eg golf club or a badminton racquet.


Load
Effort
Effort Arm
Resistance Arm
Fulcrum

Classification of Levers

Since they are 3 Points, there are 3 possibilities of arrangement- Any one of three may be situated between other Two. The arrangement of these three points provide the basis for classification-:

Class I Lever

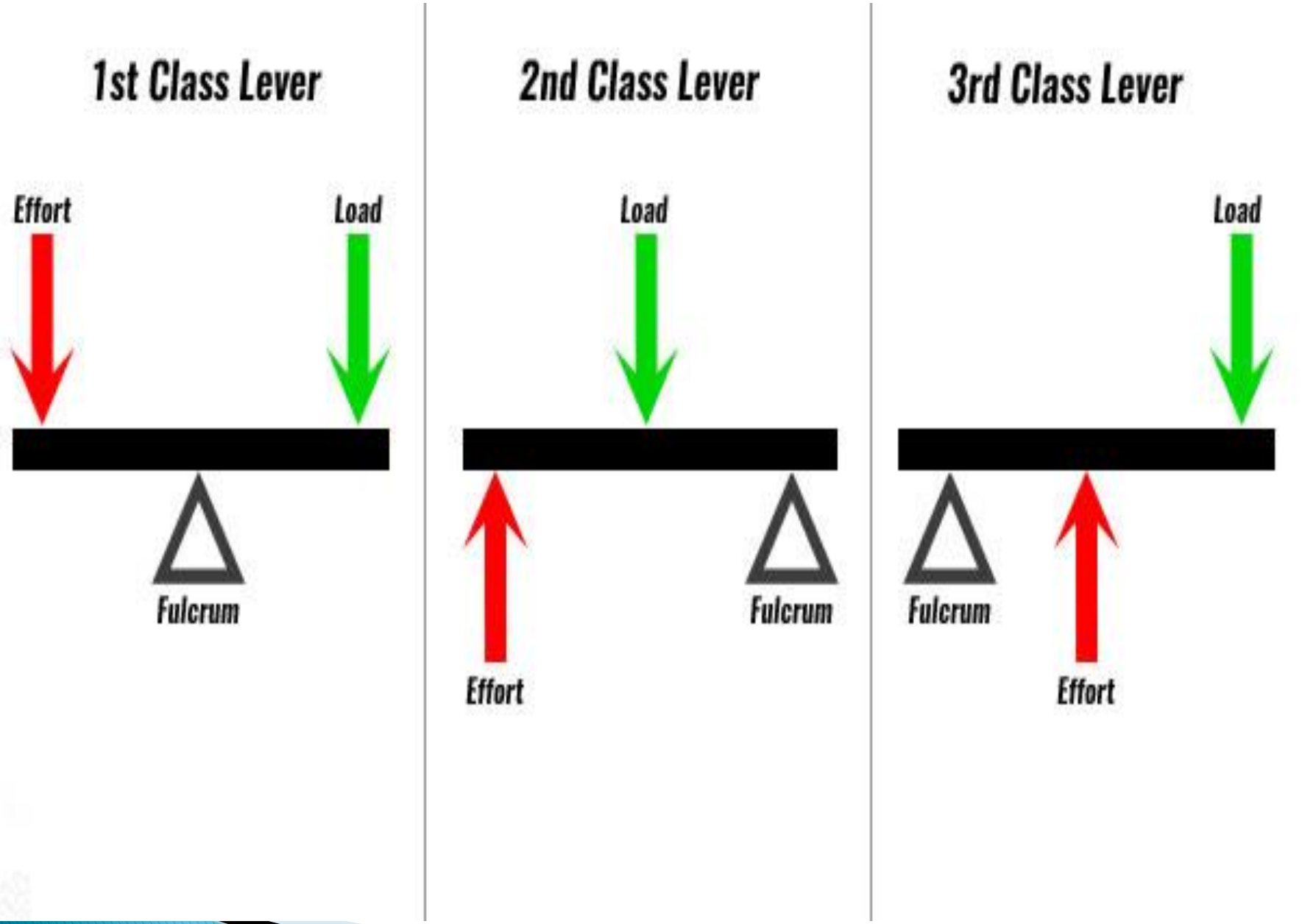
Class II Lever

Class III Lever

In a first-class lever the fulcrum is between the effort and resistance, where the lever exerts a force.

In a second-class lever the resistance is between the fulcrum and effort. For such levers, if the effort arm is longer than the resistance arm, less effort over a certain distance exerts a greater force over a shorter distance.

In a third-class lever the effort is between the fulcrum and resistance. More effort is required to move less weight, but the speed and distance moved are increased.

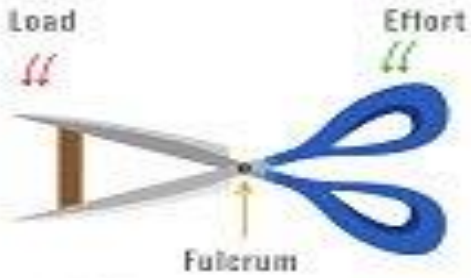

1st Class Lever
Effort
Load
Fulcrum
2nd Class Lever
Load
Fulcrum
Effort
3rd Class Lever
Load
Fulcrum
Effort

The Three Lever Classes

Types of Levers

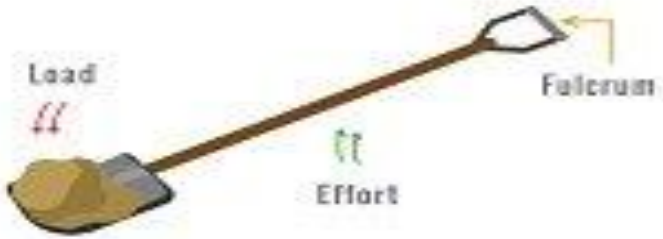
Examples

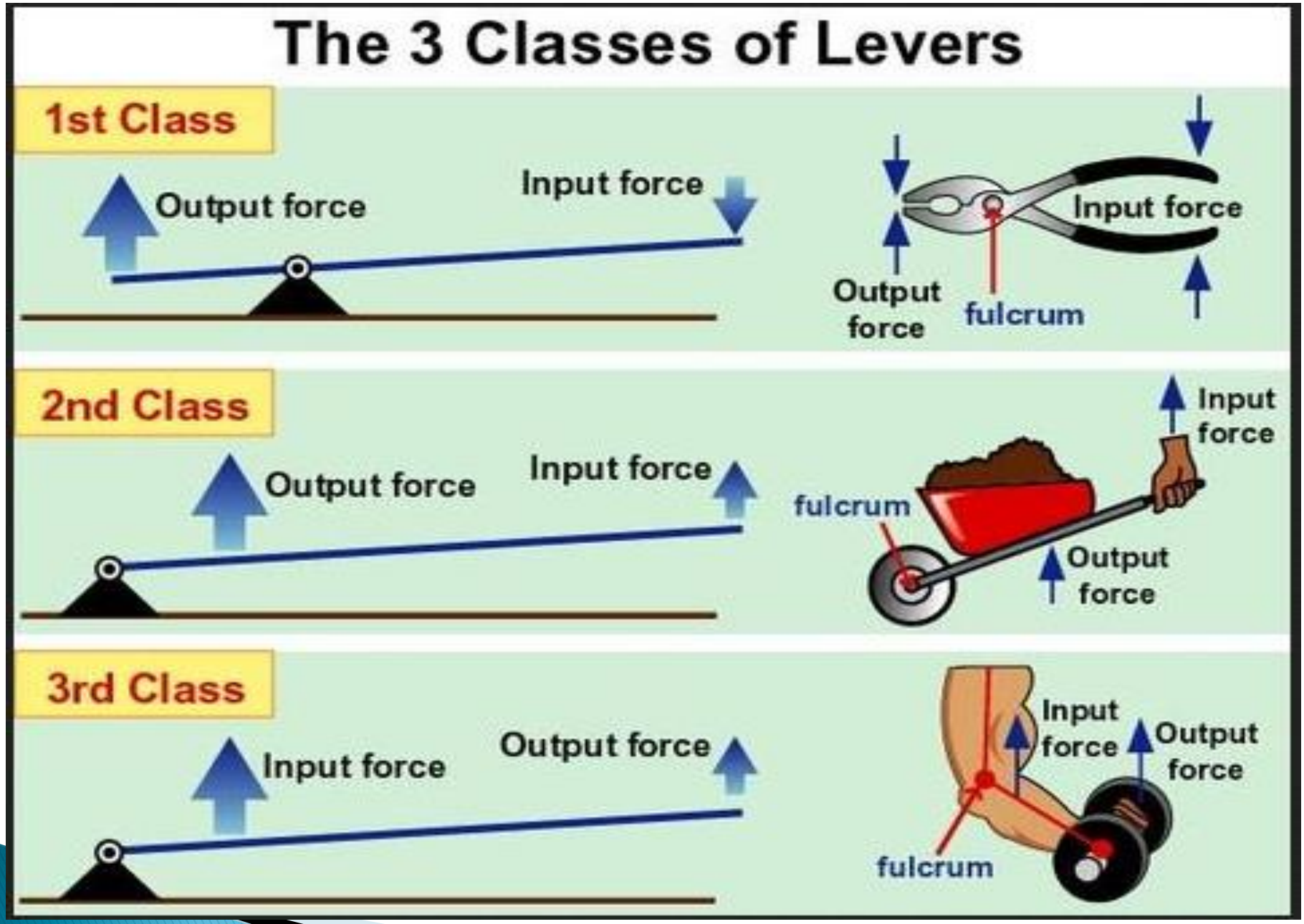
First Class



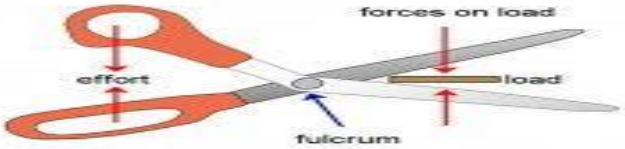
Second Class

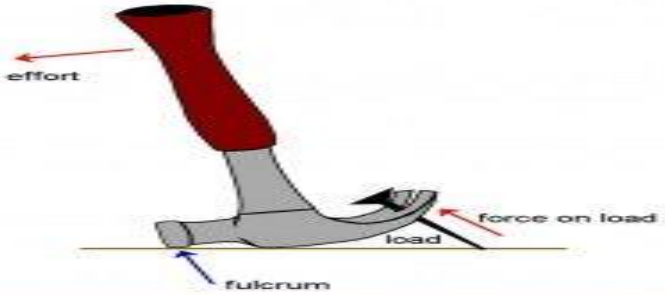
Third Class



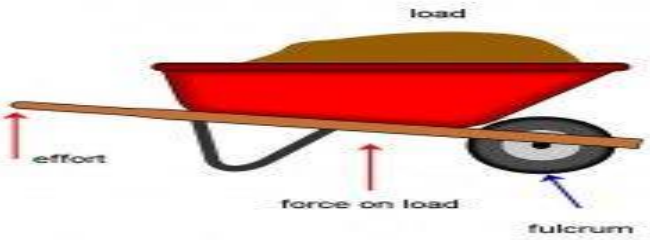

The 3 Classes of Levers
1st Class
Output force
Input force
Input force
Output force
fulcrum
2nd Class
Output force
Input force
Input force
fulcrum
Output force
3rd Class
Input force
Output force
Input force
Output force
fulcrum

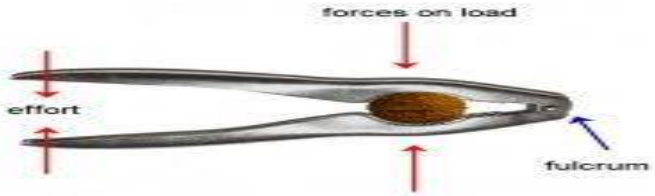
First Class Levers



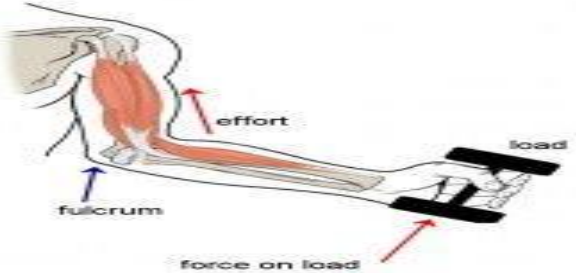


Second Class Levers





Third Class Levers



Functions of Simple Machines:

- Applying force at convenient point. Instead of applying force directly to the wheels of a bicycle, it is easier and more convenient to apply it to the pedals.
- Applying force at convenient direction. It is difficult to lift a bucket full of water directly, but the task becomes very easy if the force is applied in downward direction using a pulley.
- By applying small effort to lift large loads. In such case machine is said to be used as force multiplier. A screw jack used to lift a car or a truck.
- To change speed of motion of a body. In such case machine is said to be used as speed multiplier. Gears in automobile are used to change the speed of the automobile.

A lever system is a rigid bar that moves on a fixed point called the fulcrum when a force is applied to it. Movement is made possible in the human body by lever systems that are formed by our muscles and joints working together. An understanding of the levers in the body helps us to understand how movement is possible.

Levers in biomechanics

Muscles are attached to bones via tendons and the bones of the skeleton act as levers which muscles pull on to create movement. A lever system is made up of three parts; an effort, a load, and a fulcrum. In the human body, the effort is provided by the muscle (the muscles point of application/insertion), the load is the weight of the body and any additional resistance and the fulcrum is the joint itself.

Leverage in Human Body

There are three types found in the body, each is determined by the relative positions of the fulcrum (F), effort (E) and load (L). A useful way of determining the different types of lever systems operating during a particular movement is to remember the following rhyme.

For a first-class lever, F is the middle component.

For a second class lever, L is the middle component.

For a third-class lever, E is the middle component.

Functions of a lever system

- Lever systems have two main functions; firstly to increase the resistance that a given force can move and secondly to increase the speed at which a body moves. In addition, different types allow different ranges of movement. This means that some are effective at overcoming resistance, whilst others are able to generate speed.

First-class lever system

- In a first-class lever, the fulcrum is the middle component and lies between the effort and load. Examples of a first-class lever 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 the image below, the triceps is the effort, the fulcrum is the elbow joint and the load is the weight of the arm and Javelin. First-class levers increase both the effects of effort and the speed of the body.

- There is sometimes more than one lever system operating at the joint. 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. 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 system.

Second class lever system

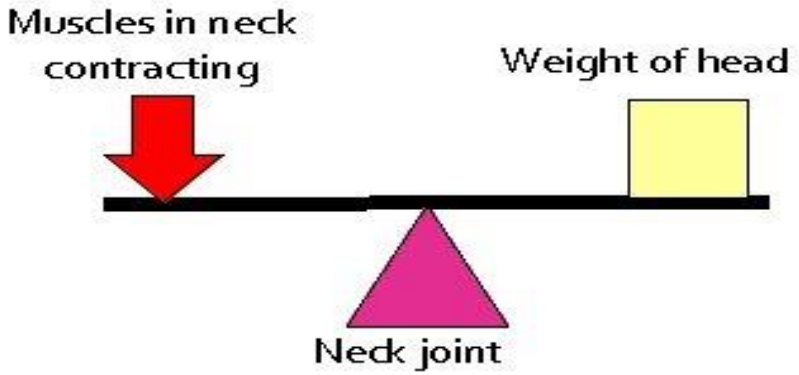
- In a second class lever system, the load is the middle component and lies between the fulcrum and the effort. Exercises involving plantar flexion at the ankle (going up on your toes) are second class lever systems, such as a calf raise or when jumping upwards whilst performing a layup in basketball. Second class lever systems only tend to increase the effect of the effort force, in other words, they are effective at overcoming resistance as opposed to generating speed.
- 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.

Third class lever system

- The majority of movements in the human body are classified as third-class lever systems. In a third-class lever system, the effort is the middle component and lies between the fulcrum and load.
- There are many examples of third class lever systems, including both flexion and extension at the knee joint. These movements are involved in running, jumping and kicking. During flexion 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. Third class lever systems are used to increase the speed of a body and allow a wide range of movement.

Class of lever – First Class

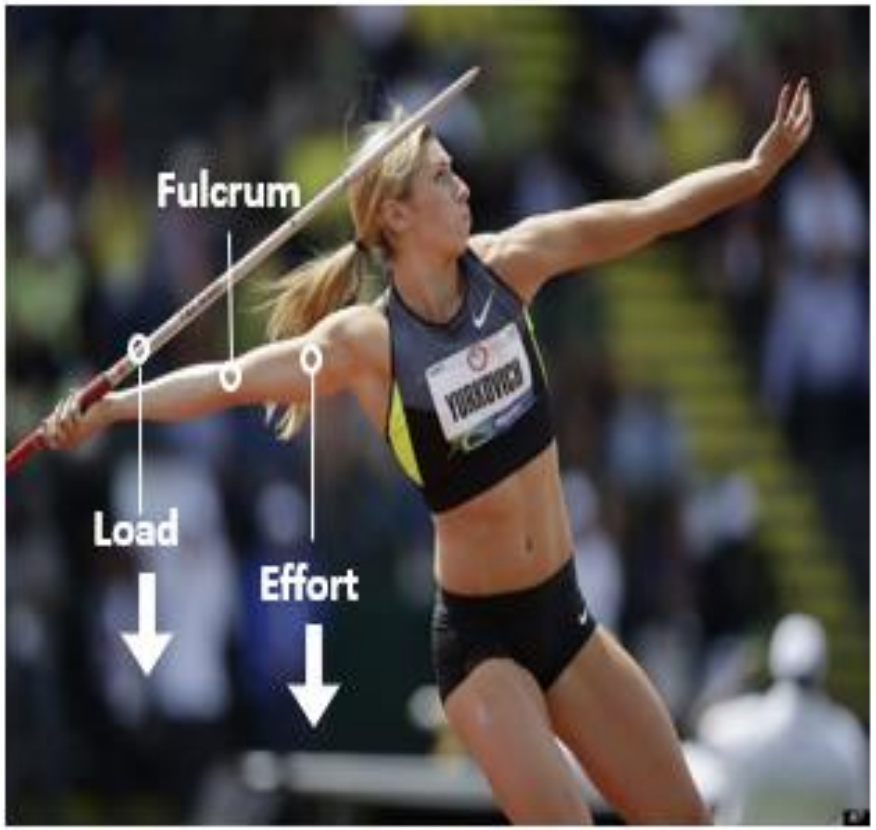
The head is a good example of the action of a first-order lever in the body when the **head and neck** are being flexed and extended, as in nodding.

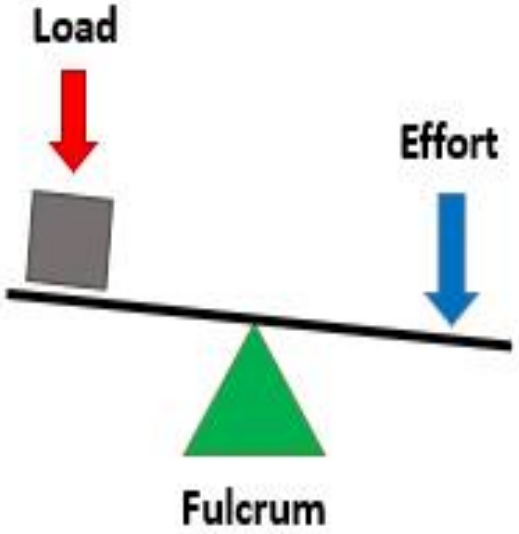


First class levers can increase both effects of effort and the speed of a body.

Types of Lever

First Class Lever





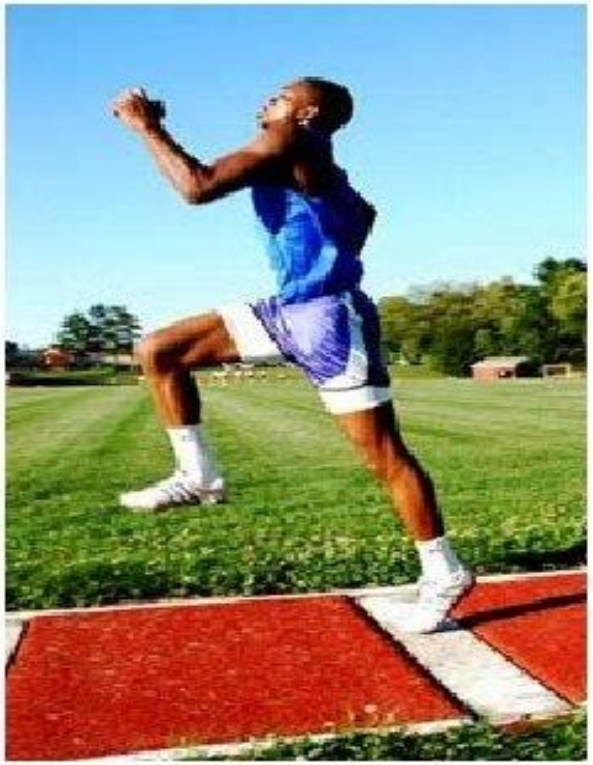
When an athlete throws a javelin, the way the arm moves is a good example of a first class lever in action. The elbow is the **fulcrum**. The **effort** is supplied by the biceps and triceps, which are both contracted to keep the arm straight, and the javelin is the **load**.

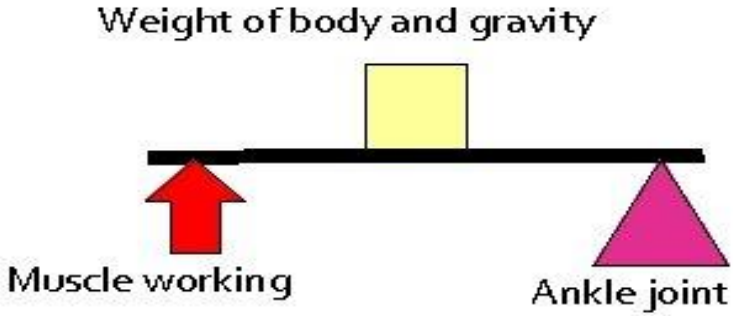
Longer levers generate greater force. The load arm becomes longer and can give greater acceleration to projectiles.

The greater the distance of the effort or the load from the fulcrum, the more significant the effort or load becomes.

Class of lever – Second Class

When you raise up on to your toes you are using a second order lever.



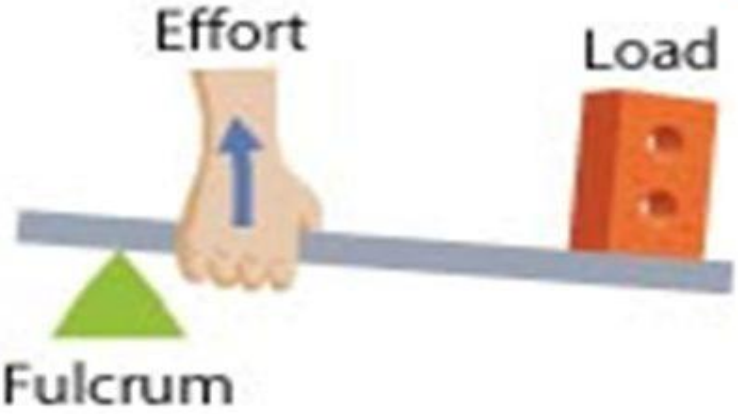


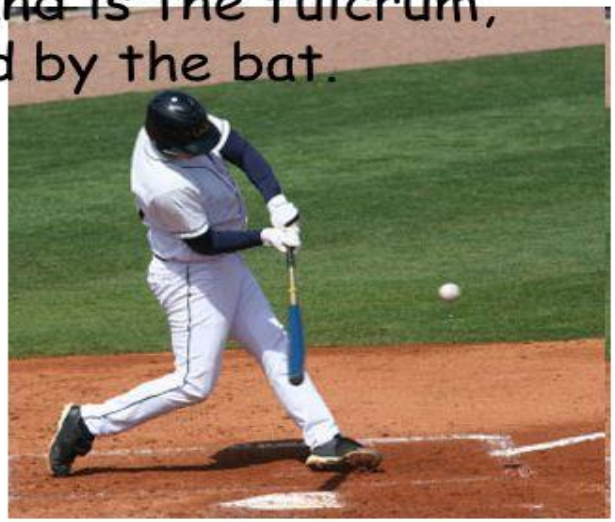
The foot is the lever bar.

Second class levers tend to increase the effect of the **effort force**.

Third Class Levers

- For a third class lever, the input force is applied between the output force and the fulcrum.
  - Example: The batter in this picture applies a force with his right hand. His left hand is the fulcrum, and the output force is exerted by the bat.





Third-Class Lever

- In a third-class lever the input force is located between the fulcrum and the output force.
- Example baseball bats, hockey sticks, & golf clubs