Levers & Other Simple Machines

What simple machine is represented in your body?

We’re going to focus on the lever, not other simple machines, because our bones function as levers in our bodies to help us move.

A lever can be made by balancing a board on a log.

- Pulling down on one end of the board, the input force, lifts a load on the other end of the board.
- The upward force the board exerts on the load is the output force.

Examples of levers include: pliers, a wheelbarrow, and the human biceps and forearm.

All levers include a stiff structure (the lever) that rotates around a fixed point called the fulcrum.

- The side of the lever where the input force is applied is called the input arm.
- The output arm is the end of the lever that moves the rock or lifts the heavy weight.

Levers are useful because you can arrange the fulcrum and the input and output arms to adapt to the task you need to perform.
The ability of a lever to perform a task depends on its mechanical advantage.

- Mechanical advantage is the ratio of output force produced by a simple machine to the applied input force.
- The higher the output force in relation to the input force, the greater the mechanical advantage.

You can calculate mechanical advantage by dividing the output force, in newtons, by the input force, in newtons as shown in the formula below:

\[ MA = \frac{F_o}{F_i} \]

Levers confer mechanical advantage.

- The input force that is applied to a lever and the output force are related to the lengths of the input and output arms.

When the input and output arms are the same length (because the fulcrum is in the middle of the lever), the input and output forces are the same.

The input and output forces are different if the fulcrum is not in the center of the lever.

- The side of the lever with the longer arm has the smaller force.

For some levers, the output arm is longer than the input arm and the output force is less than the required input force.

- Levers designed this way achieve a wide range of motion on the output side.
- For example, a broom is a lever used to sweep floors.
Classes of Levers

- There are three types of levers.
- They are classified by the locations of the input and output forces relative to the fulcrum.

- When the fulcrum is in the middle, the lever is a 1st class lever.
- When the load is in the middle, the lever is a 2nd class lever.
- 3rd class levers have the effort force in the middle.

First-class levers always have the fulcrum between the input force and the output force.

Second class levers always have the output force between the fulcrum and the input force.

Third class levers always have the input force between the fulcrum and the output force.

Third-class levers do result in a wide range of motion that is important in moving your arms or sweeping large areas when you use a broom.
A mnemonic to remember which part is in the middle for each lever class:

“There’s a FLE in the middle of my lever!”
- The first letter is F (for fulcrum in the middle),
- the second letter is L (for load in the middle), and
- the third letter is E (for effort in the middle).