

Mechanical advantage

A **machine** is a device that does a physical task. Machines can:

- Make doing work easier by reducing the input force needed.
- Change the distance over which the input force is exerted.
- Change the direction of the force.

Basically, machines allow work to be done with less effort. In other words, they give us a **mechanical advantage**.

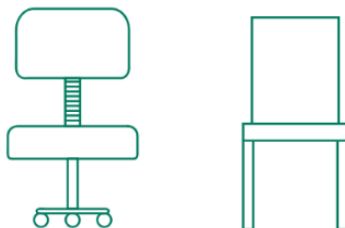
Mechanical advantage is the advantage gained by using a machine in transmitting force. Mechanical advantage compares the force produced *by* a machine with the force applied *to* the machine.

In other words, mechanical advantage is the benefit you get from using the machine.

Here's an example

A common machine is the wheel and axle. Wheels make it a lot easier to move things. Think about chairs. Some chairs have wheels on them and some don't.

If you had to push a chair across the room, which would take less effort to move?



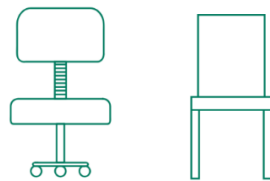
The wheels offer you a mechanical advantage, making it easier to move that chair!

Calculating mechanical advantage

Mechanical advantage is a ratio that compares how much work goes into a machine to how much work comes out of the machine. In other words, it is the factor by which the machine multiplies force.

Here's an example

Think back to the two chairs.



Let's say you push both chairs with the same amount of force. The chair without wheels slides 18 centimetres. The chair with wheels slides 85 centimetres. The output result is different for the two chairs, even though the input was the same.

This is because the wheels offer a mechanical advantage. The wheels turned your same input force into more output.

You can calculate the mechanical advantage (MA) by dividing the force of resistance (which is the load) by the force of effort.

$$\text{Mechanical Advantage} = \frac{\text{Force of resistance}}{\text{Force of effort}}$$

This is often written as:

$$MA = \frac{Load}{Effort}$$

Depending on the type of machine, the inputs you use in the equation will change. However, mechanical advantage always gives a ratio of how effective the machine is at multiplying force in *compared to* force out.

There is no unit for mechanical advantage since the unit for both input and output forces cancels out.

