

Mechanical Advantage



Simple Machines

- A device that makes work easier.



Simple Machines

- A machine is a device that helps make work easier to perform by accomplishing one or more of the following functions:
 - transferring a force from one place to another
 - changing the direction of a force
 - changing the magnitude of a force
 - changing the distance or speed of a force

Simple Machines

- The six simple machines are:
 - Lever
 - Wheel and Axle
 - Pulley
 - Inclined Plane
 - Wedge
 - Screw

Mechanical Advantage

- A machine's mechanical advantage (MA) is the number of times a force exerted on a machine is multiplied by the machine.
- The MA is a RATIO between the output and input force (no units!)

Forces involved:

- Input Force
(Effort Force)

- F_i or F_e

- Force applied TO a machine

- Output Force
(Resistance Force)

- F_o or F_r

- Force applied BY a machine

Mechanical Advantage

- When a machine takes a small input force and increases the magnitude of the output force, a *mechanical advantage* has been produced.

$$MA = \frac{F_o}{F_i}$$

$$MA = \frac{F_r}{F_e}$$

Mechanical Advantage

- In machines that increase distance instead of force, the MA is the ratio of the output distance and input distance.

$$MA = \frac{d_i}{d_o}$$

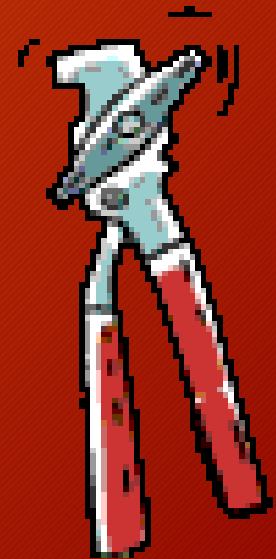
$$MA = \frac{d_e}{d_r}$$

No machine can increase *both* the magnitude and the distance of a force at the same time.

Practice Problem

If you exert a force of 20 N on a can opener, and the opener exerts a force of 60 N on the can, the ideal mechanical advantage of the can opener is:

- A. 6
- B. 0.3
- C. 1200
- D. 3



Mechanical Advantage > 1

- A machine with a mechanical advantage of greater than 1 multiplies the input force.
- Examples: can opener
a ramp



Mechanical Advantage < 1

- A machine with a mechanical advantage of less than 1 does not multiply the force but increases the distance and speed.
- Examples: Hockey Stick
Paper Fan



Mechanical Advantage = 1

- A machine with a mechanical advantage of 1 means that a machine changes the direction of the force.
- Example: Rope



Practice Problem

A wheelbarrow has a mechanical advantage of 2.2. The output distance extends from the load's center of mass to the wheel, and the input distance is from the handles to the wheel. For an output distance of 0.45m, what is the input distance?