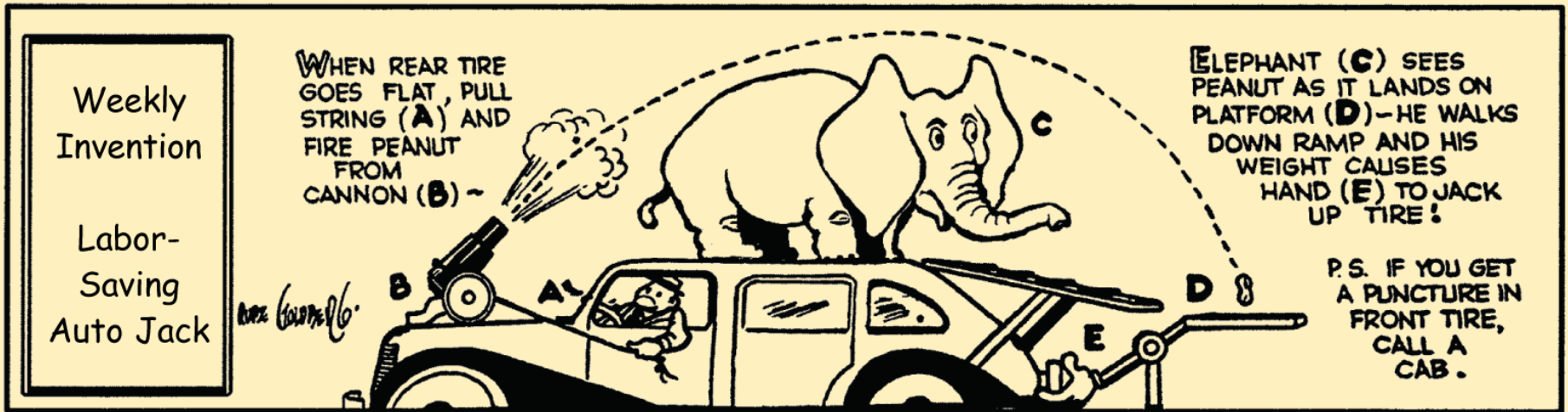


The output of one device acts as the input of the next.





**What are the six types of simple machines?**



**The six types of simple machines are the lever, the wheel and axle, the inclined plane, the wedge, the screw, and the pulley.**

## Levers



**What determines the mechanical advantage of the six types of simple machines?**



**To calculate the ideal mechanical advantage of any lever, divide the input arm by the output arm.**

## Levers

A **lever** is a rigid bar that is free to move around a fixed point.

The fixed point the bar rotates around is the **fulcrum**.

## Levers

The **input arm** of a lever is the distance between the input force and the fulcrum.

The **output arm** is the distance between the output force and the fulcrum.

Levers are classified into three categories based on the locations of the input force, the output force, and the fulcrum.

## Levers

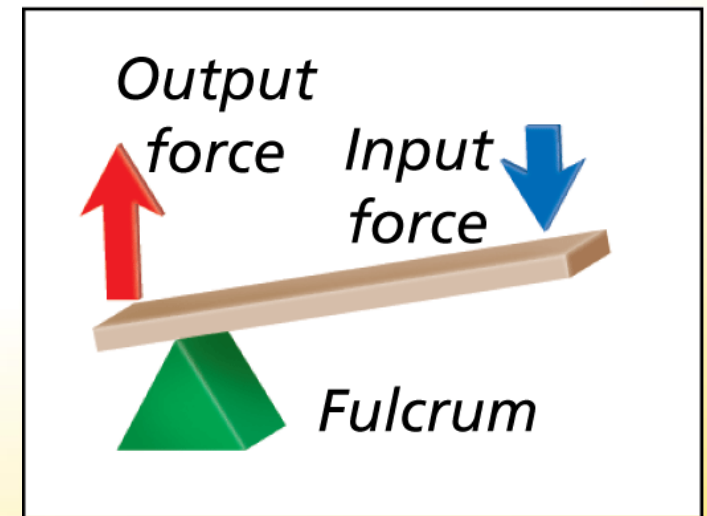
### First-Class Levers

The fulcrum of a first-class lever is always located between the input force and the output force.

Depending on the fulcrum position, the mechanical advantage can be greater than 1, equal to 1, or less than 1.

## Levers

The screwdriver is being used as a first-class lever with a mechanical advantage greater than 1.



(Diagram is not drawn to scale.)



## Levers

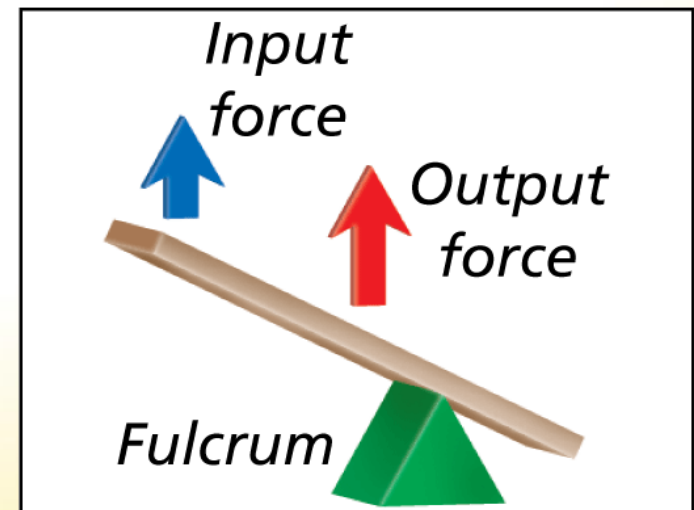
### Second-Class Levers

- In a second-class lever, the output force is located between the input force and the fulcrum.
- The input distance is larger than the output distance.
- The mechanical advantage of a second-class lever is always greater than 1.



## Levers

The wheelbarrow has its output force located between the input force and the fulcrum.



(Diagram is not drawn to scale.)

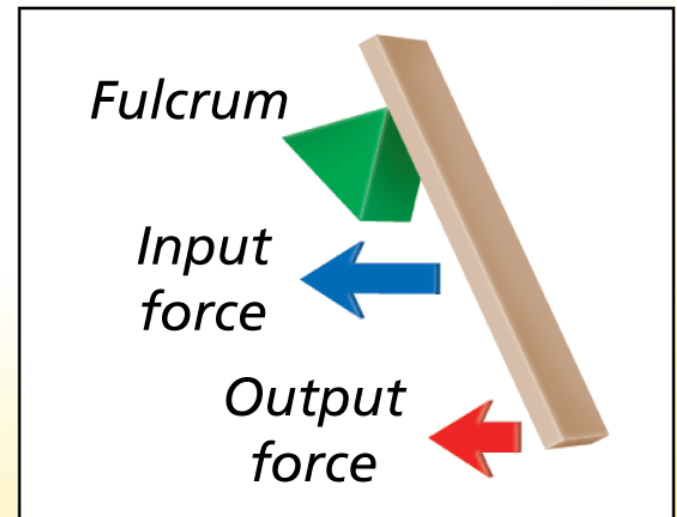
## Levers

### Third-Class Levers

- The input force of a third-class lever is located between the fulcrum and the output force.
- The output distance over which the third-class lever exerts its force is larger than the input distance.
- The mechanical advantage of a third-class lever is always less than 1.

## Levers

The output distance of the broom is greater than the input distance the hands move through.



(Diagram is not drawn to scale.)

## Wheel and Axle



To calculate the ideal mechanical advantage of the wheel and axle, divide the radius (or diameter) where the input force is exerted by the radius (or diameter) where the output force is exerted.

## Wheel and Axle

A **wheel and axle** is a simple machine that consists of two disks or cylinders, each one with a different radius.

The outer disk is the wheel and the inner cylinder is the axle. The wheel and the axle rotate together as a unit.



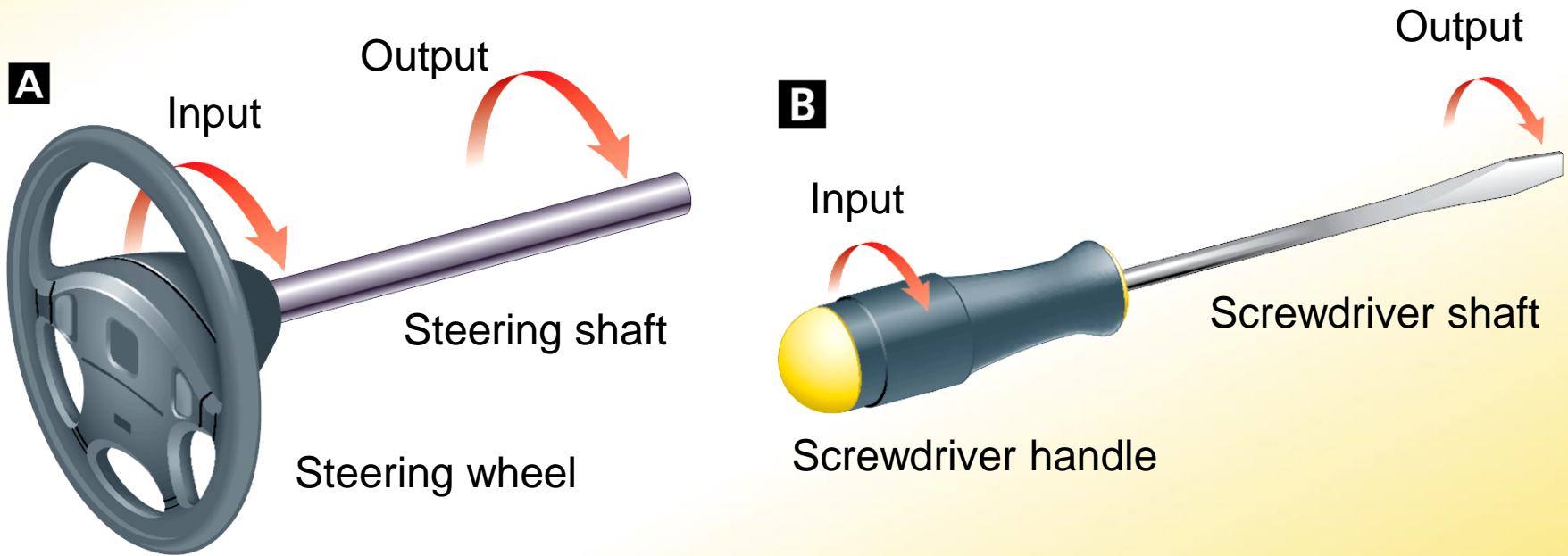
## Wheel and Axle

The input force can be exerted on the wheel or the axle.

- If the force is applied to the wheel, the input distance is larger than the output distance. The mechanical advantage is greater than 1.
- If the force is applied to the axle, the output distance is larger than the input distance. The mechanical advantage is less than 1.

## Wheel and Axle

A wheel and axle is a type of simple machine consisting of two disks or cylinders with different radii.





## Inclined Planes



**The ideal mechanical advantage of an inclined plane is the distance along the inclined plane divided by its change in height.**

## Inclined Planes

An **inclined plane** is a slanted surface along which a force moves an object to a different elevation.

- The distance traveled is the input distance.
- The change in height of the ramp is its output distance.
- The mechanical advantage of an inclined plane is greater than 1.

# Inclined Planes

This long and winding road acts like an inclined plane.



## Wedges and Screws



**A thin wedge of a given length has a greater ideal mechanical advantage than a thick wedge of the same length.**



**Screws with threads that are closer together have a greater ideal mechanical advantage.**

## Wedges and Screws

### Wedges

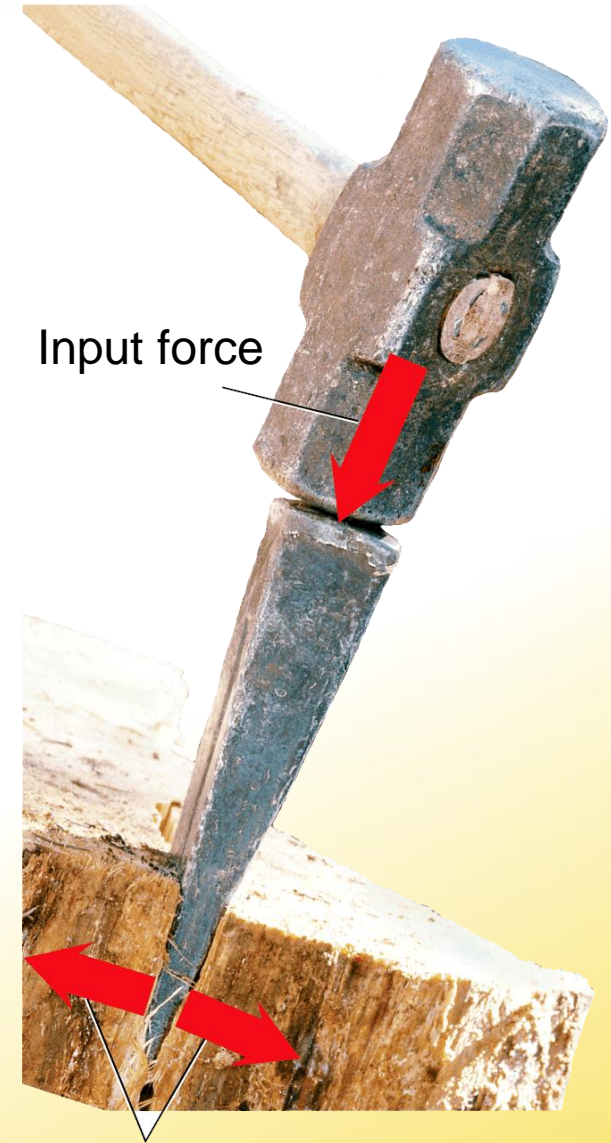
A **wedge** is a V-shaped object whose sides are two inclined planes sloped toward each other.

A wedge has a mechanical advantage greater than 1.



## Wedges and Screws

The wedge consists of two inclined planes that slope toward each other. The inclined planes force the wood fibers apart as the wedge is driven into the log.



## Wedges and Screws

### Screws

A **screw** is an inclined plane wrapped around a cylinder.

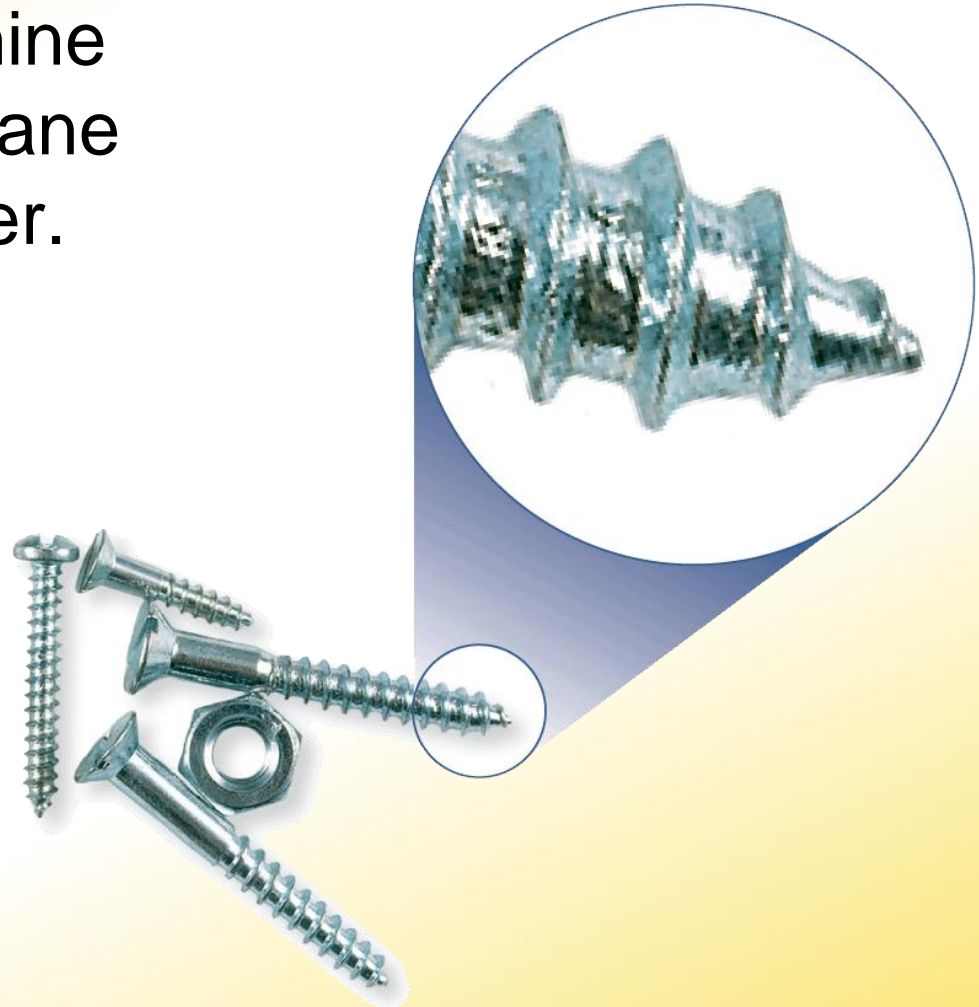
For two screws of the same length, the one whose threads are closer together moves forward less for each turn of the screw.

A screw has a mechanical advantage greater than 1.



## Wedges and Screws

A screw is a simple machine made up of an inclined plane wrapped around a cylinder.



# Pulleys



**The ideal mechanical advantage of a pulley or pulley system is equal to the number of rope sections supporting the load being lifted.**

## Pulleys

A **pulley** is a simple machine that consists of a rope that fits into a groove in a wheel.

- Pulleys produce an output force that is different in size, direction, or both, from that of the input force.
- The mechanical advantage of a pulley can be equal to or greater than 1.

# Pulleys

A pulley moves a large fabricated part through a factory.



# Pulleys

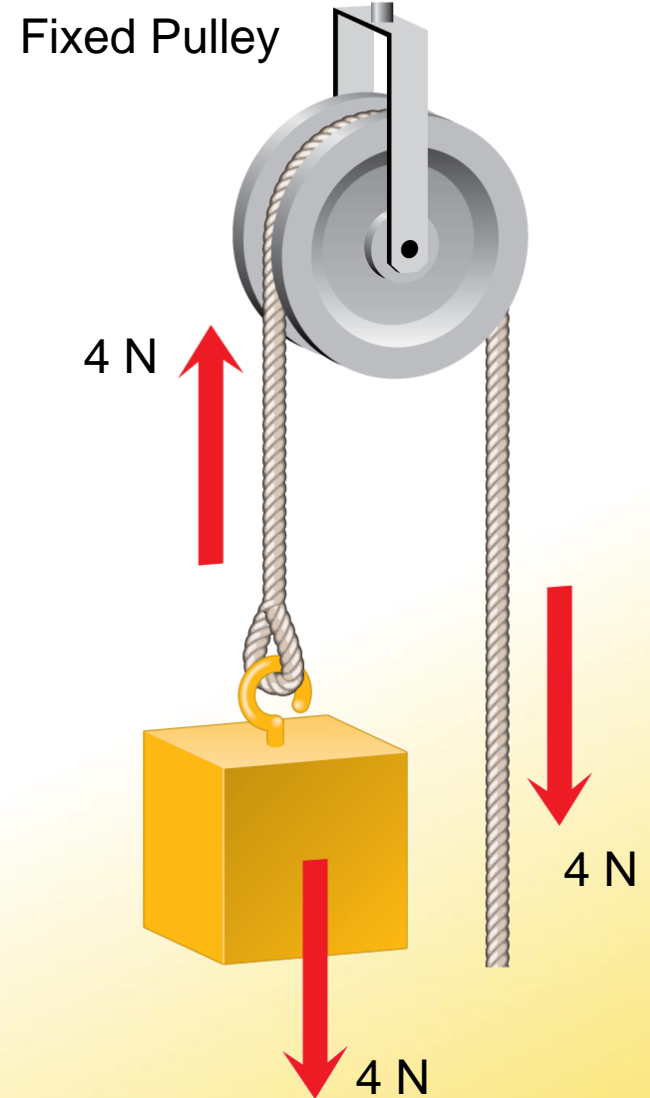
## Fixed Pulleys

A fixed pulley is a wheel attached in a fixed location. The direction of the exerted force is changed by a fixed pulley, but the size of the force is not.

The ideal mechanical advantage of a fixed pulley is always 1.

## Pulleys

A fixed pulley changes only the direction of the input force.





# Pulleys

## Movable Pulley

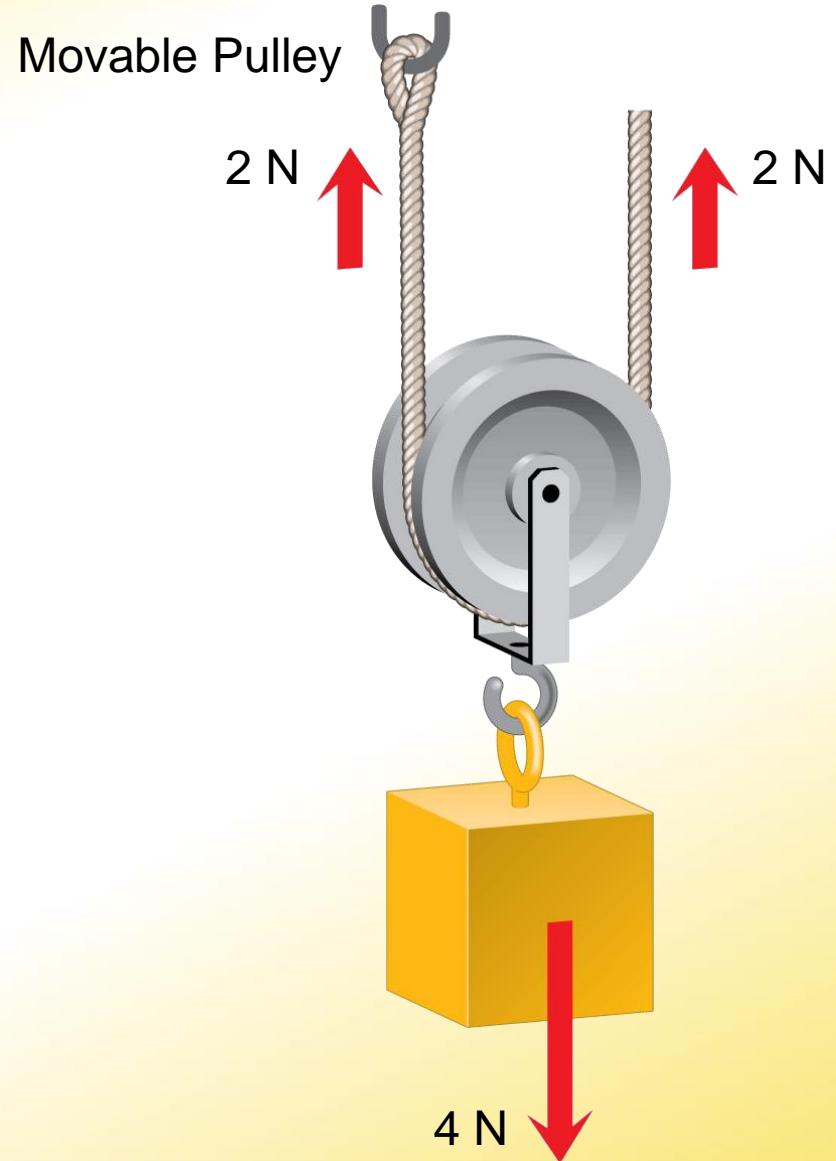
A movable pulley is attached to the object being moved rather than to a fixed location.

- Both sections of the rope pull up with the same force.
- The movable pulley has a mechanical advantage of 2.



## Pulleys

Movable pulleys change both the direction and the size of the input force.



# Pulleys

## Pulley System

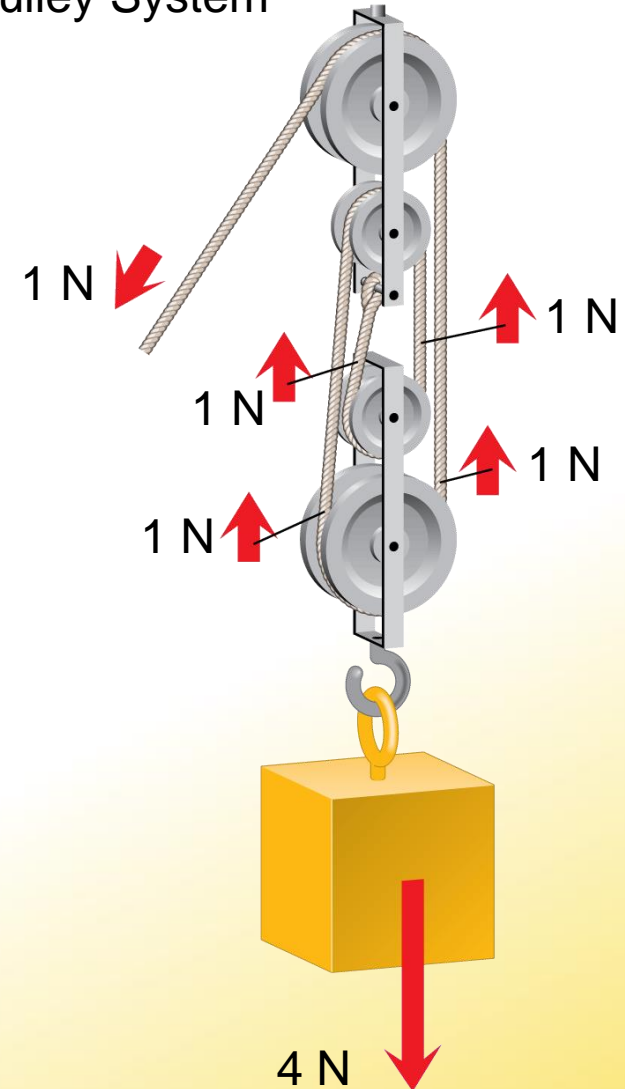
A large mechanical advantage can be achieved by combining fixed and movable pulleys into a pulley system.

- The mechanical advantage depends on how the pulleys are arranged.
- The ideal mechanical advantage of a pulley system is equal to the number of rope sections supporting the load being lifted.

## Pulleys

Pulley systems are made up of both fixed and movable pulleys.

Pulley System



## Compound Machines

- A **compound machine** is a combination of two or more simple machines that operate together. Most of the machines you use are compound machines.
- The edges of a pair of scissors are sharpened like wedges. The blades and the handles together function as levers.
- Cars, washing machines, and clocks are combinations of hundreds or thousands of simple machines.

## Assessment Questions

1. A bar that is rotating about a fixed point is called a
  - a. fulcrum.
  - b. lever.
  - c. wedge.
  - d. compound machine.

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ANS: B

## Assessment Questions

2. A 3-meter-long ramp is used to lift a piano to a moving truck, which is 1 meter off the ground. What is the ideal mechanical advantage of the ramp?
- a. 1
  - b. 2
  - c. 3
  - d. 33



## Assessment Questions

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  - b. 2
  - c. 3
  - d. 33

ANS: C

## Assessment Questions

1. A machine, such as a bicycle, that combines many simple machines is known as a complex machine.

True

False

## Assessment Questions

1. A machine, such as a bicycle, that combines many simple machines is known as a complex machine.

True

False

ANS: F, compound machine