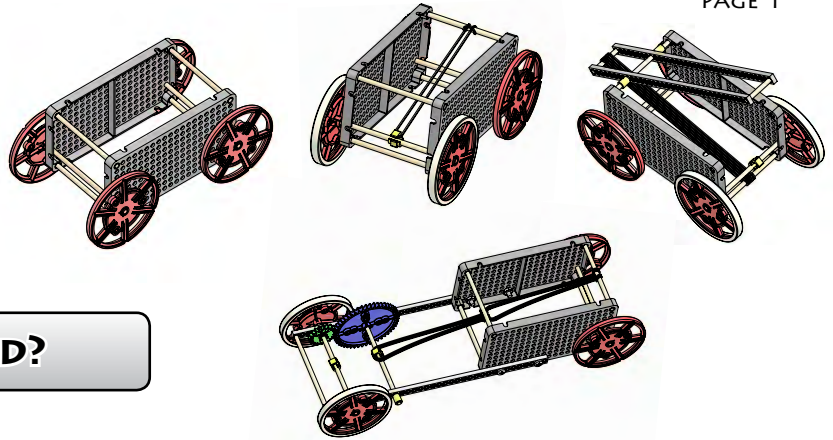


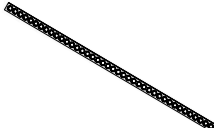

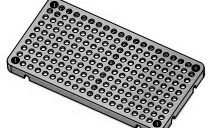
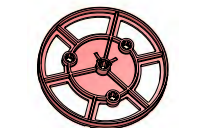




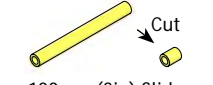




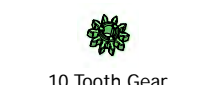



## THE ACTIVITY

Build, race and re-engineer a rubber band powered vehicle, while applying the science concepts of energy, simple machines and friction.


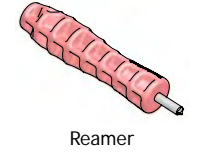





## WHAT WILL YOU NEED?

Materials to build one rubber band racer:

 Connector Strip Basic Quantity: 4 Advanced Quantity: 6	 300mm (~12in) Dowels Basic Quantity: 4 Advanced Quantity: 6	 Hole Plate Basic Quantity: 2 Advanced Quantity: 2	 Wheel Hub Basic Quantity: 4 Advanced Quantity: 4	 Stretch Tire Basic Quantity: 2 Advanced Quantity: 2	 #16 Rubber Band Basic Quantity: 10 Advanced Quantity: 10
 1in Machine Screw, #10 Basic Quantity: 4 Advanced Quantity: 8	 Nut, #10 Basic Quantity: 4 Advanced Quantity: 8	 100mm (3in) Slide Stop Cut 6mm (1/4in) Sections Basic Quantity: 1 Advanced Quantity: 1	 Stop Clip Basic Quantity: 2 Advanced Quantity: 4	 50 Tooth Gear Basic Quantity: 0 Advanced Quantity: 1	 40 Tooth Gear Basic Quantity: 0 Advanced Quantity: 1
 20 Tooth Gear Basic Quantity: 0 Advanced Quantity: 1	 10 Tooth Gear Basic Quantity: 0 Advanced Quantity: 1	Required materials, not included:  String	Suggested materials, not included:  Recycled & Found	Other approved materials: 	Gear & Pulley Colors will vary.

Tools to build a rubber band racer:

 Cutter	 Reamer	 Wax, Soap or Crayon	 Optional: Hammer	 Optional: Pliers
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Build it, test it, change it. TeacherGeek™ components allow you to design and engineer your most imaginative mechanisms. Combine them with other materials and products. More resources are available at [teachergeek.com](http://teachergeek.com).

## DOWELS

Dowels vary in diameter. Some may be too large or small to use.

The ends of dowels may taper and need to be cut off to fit tightly into holes.

## CUTTING

Dowels and Connector Strips can be cut with a multi-cutter (best method), saw, side cutters or pruning shears. Wear safety glasses when cutting.



Multi-Cutters

## HOLES & REAMING

Components come with holes that dowels press securely into.

Reaming holes to allow dowels to rotate and slide freely.

Turn a reamer back and forth through a hole.

**Ream**

## PUSH, WIGGLE, TAP

Push dowels into holes by:

1. Wiggling and pressing with your hands
2. Tapping dowels with a hammer or the side of your cutter.

Tip: Rub a dowel with soap, wax or a crayon to allow it to slide easier into and out of holes.

## START BUILDING!!!



## WARNING!!!

Most holes should not be reamed. Do not ream holes which dowels should stay pressed into.

## 1. THE FRAME

Cut four 100mm (4in) dowels. Insert them into two hole plates as shown. Tip: Wax the dowel ends as shown above.

Hole Plate

Dowel

The assembled frame should look like this.

**Do not ream holes.**

## 2. WHEELS

Cut two 125mm (5in) dowels. They will become axles. Insert them into two wheels.

Wheel

**Do not ream holes.**

## 3. MORE WHEELS

Place the wheel & axles from step 3 through the frame (where you think they will function best). They can be moved later.

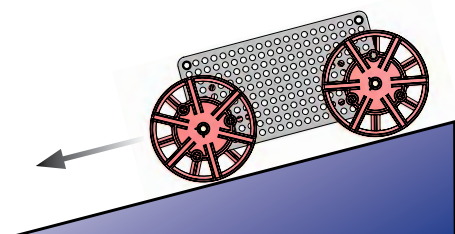
Press the two remaining wheels onto the axles

Tip: Wheels should not be tight against the frame.

**Do not ream.**

## 4. LET IT ROLL

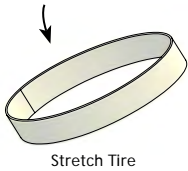
Roll your racer across the floor or down a ramp. Reduce friction, allowing it to roll the furthest possible distance.



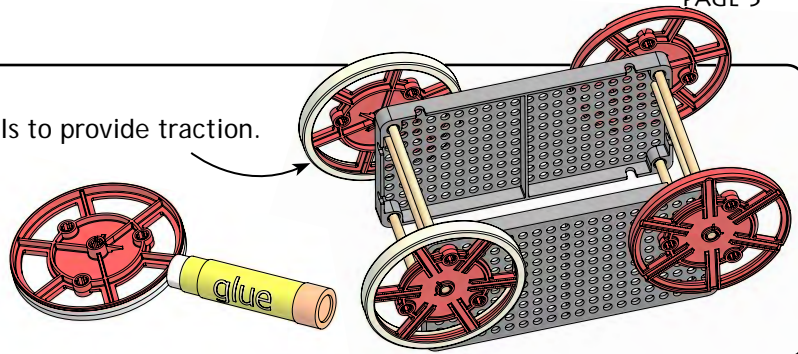


## 5. ADD TRACTION

Rubber tires can be stretched around your wheels to provide traction.

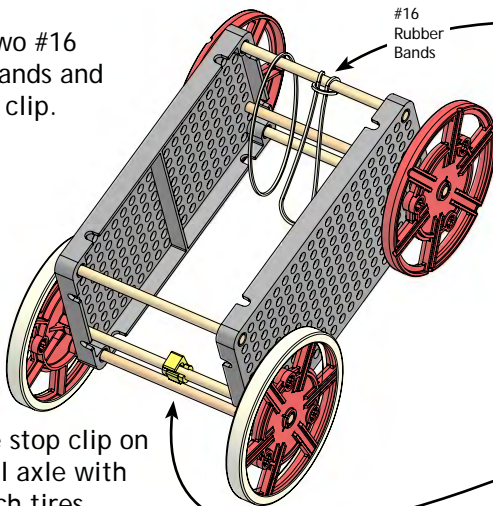


Tip: Applying glue to the outside of the wheel will help the stretch tire stay on (after it dries).

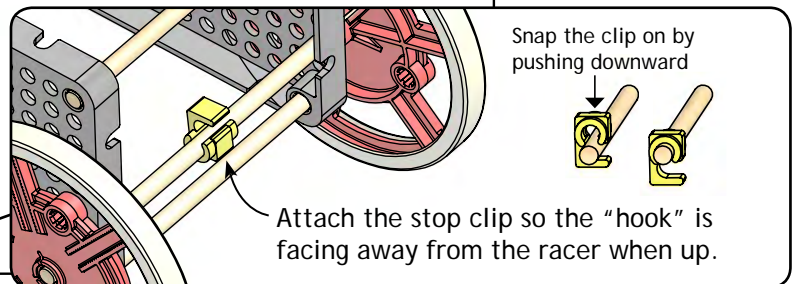
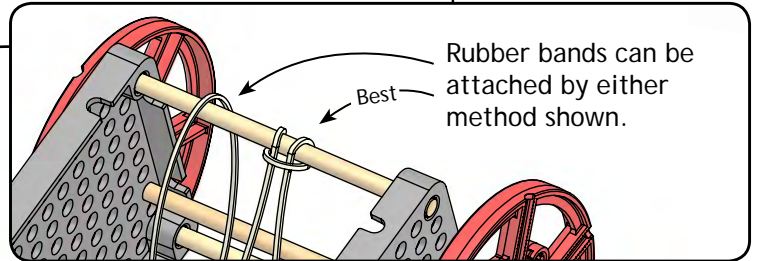


## 6. CLIP AND BANDS

Attach two #16 rubber bands and one stop clip.

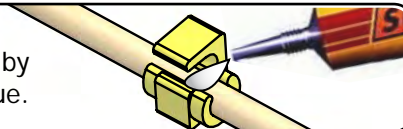


Place the stop clip on the wheel axle with the stretch tires.



## 7. SECURE THE CLIP

The stop clip may slip (rotate on the axle) when pulled by a rubber band. This can be prevented with a drop of glue.

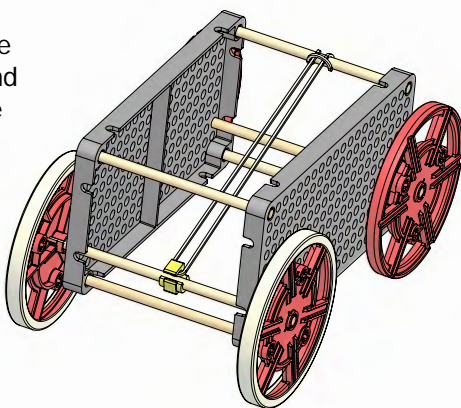


You may invent your own way to hook the rubber band.

## 8. WIND IT UP & LET IT GO

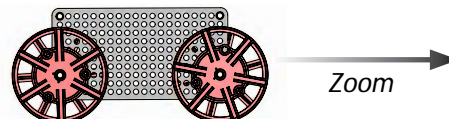
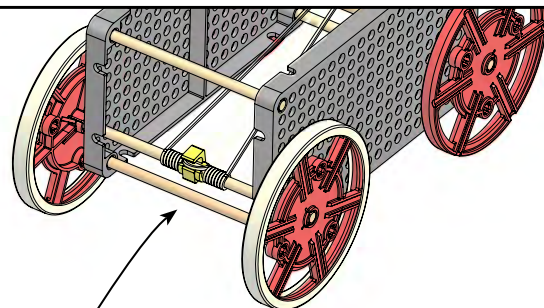
Wind-up your rubber band racer:

a) Hook the rubber band around the clip.



b) Wind the rubber band around the axle by pulling the racer backwards with wheels on the ground, or by holding the racer and turning the wheels backward with your hands.

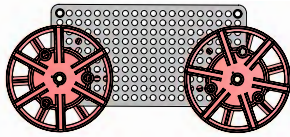
c) Let it go!!!



## EXTREME CHALLENGES

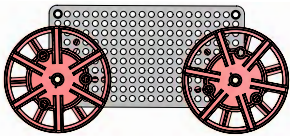
It's time to re-engineer your current rubber band racer to compete in extreme challenges. Build it for one competition, change it for another.

Extreme Distance



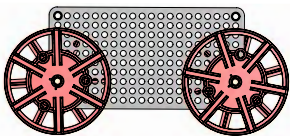
Slow & Far

Dragster

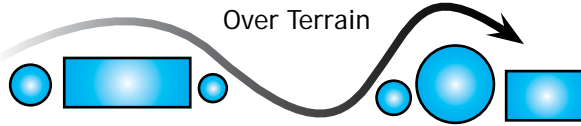


Short & Fast

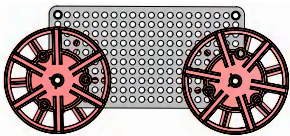
All-Terrain



Over Terrain



Precision Stop / Shuffleboard



Precision Distance

Competition documents can be downloaded at TeacherGeek.com.

## MECHANICAL ADVANTAGE (IDEAL)

Mechanical Advantage is the relationship between the input force (work in) and the output force (work out).

$$\text{Work}_{\text{in}} = \text{Work}_{\text{out}}$$

Work equals force times distance, so we can say...

$$\text{Force}_{\text{in}} \cdot \text{Distance}_{\text{in}} = \text{Force}_{\text{out}} \cdot \text{Distance}_{\text{out}}$$

Input Force  
Also called "Effort"

The distance over which the input force is applied

Output Force

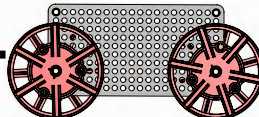
The distance over which the output force is applied

Some energy is lost due to friction and mass.



The force released by a rubber band contracting over a distance...

converts to...

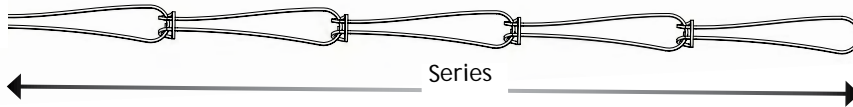


the force of the racer and the distance it travels.

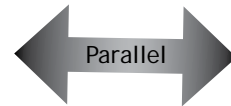


## PARALLEL OR SERIES

Rubber bands can be connected in series (forming a thin long band), or in parallel (forming a short, thick band).



Rubber bands in series store and release less force over a greater distance.

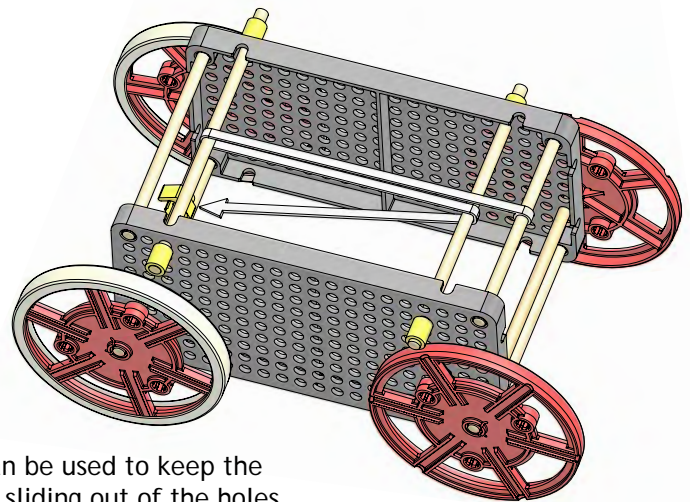
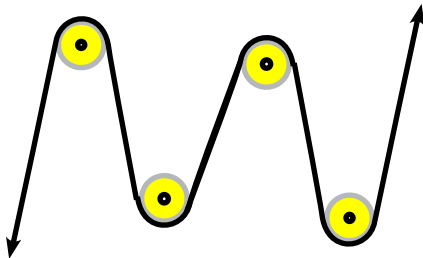


Rubber bands in parallel store and release greater force over a less distance.

This

## ROUTING

Pulleys can be used to change the direction of a rubber band, or string, and the force it applies. Dowels, allowed to spin in loose fit holes, can be used as pulleys.



Slide stop can be used to keep the dowels from sliding out of the holes.

## FRAME EXTENSION

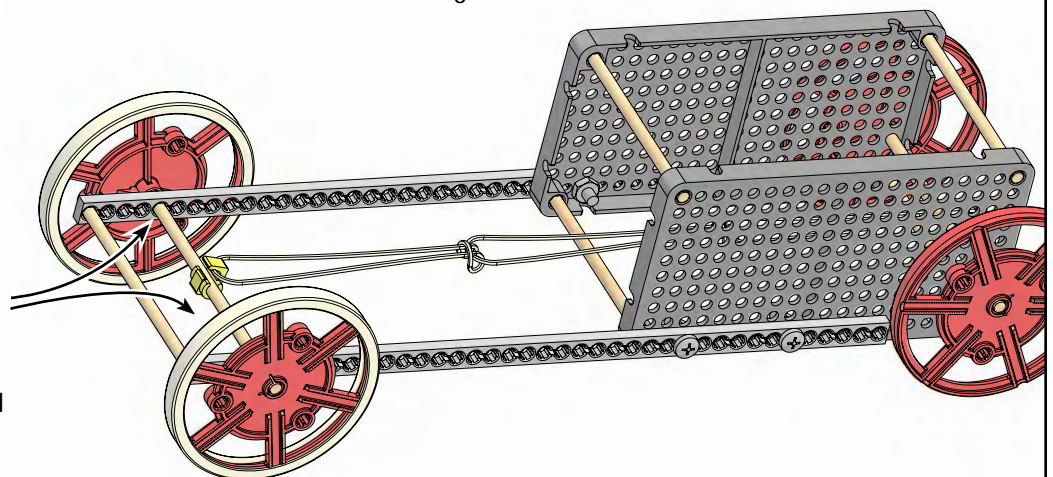
Connector strips can be used to make a vehicle frame taller or longer.



The only reamed holes are those in the connector strips that the wheel axles pass through.



No other holes should be reamed.



## LEVER ARM

A lever arm and string can create a mechanical advantage between the rubber bands and the driven wheels to increase distance traveled or vehicle speed.

### STEP 1

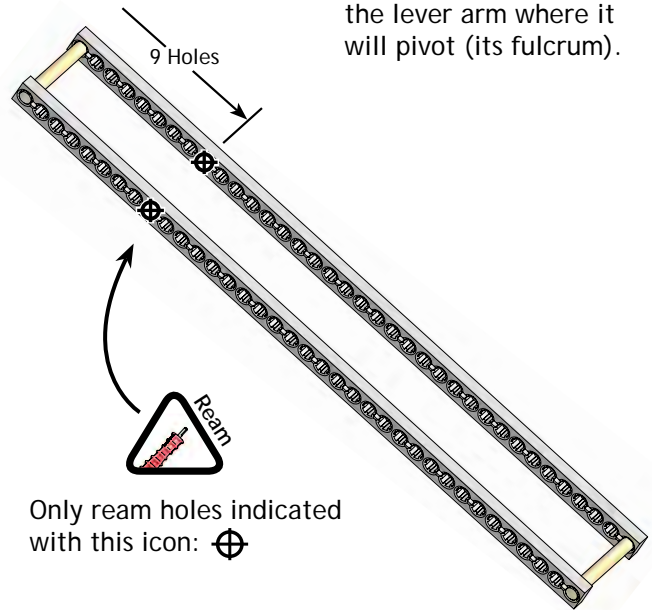


Connector strips joined by 2 or more dowels makes a stiff lever arm.



Do not ream any other holes.

### STEP 2



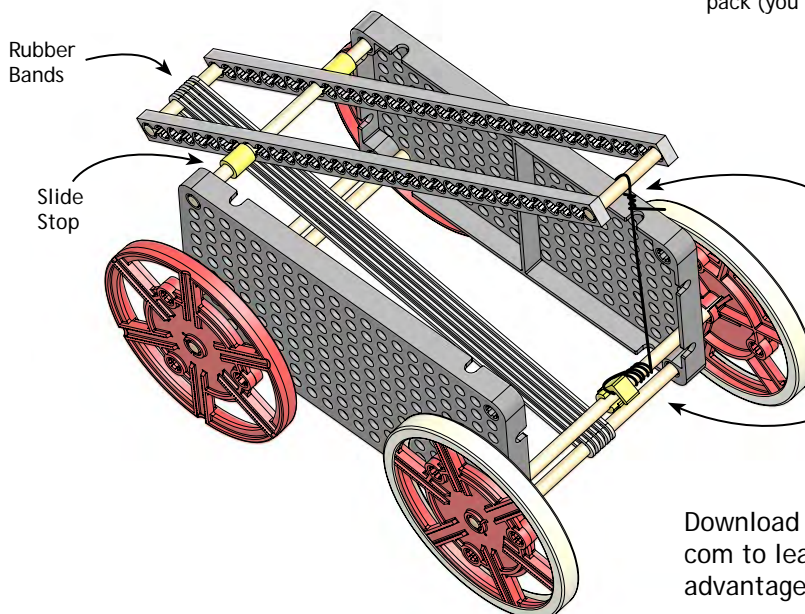
Holes must be reamed in the lever arm where it will pivot (its fulcrum).

Only ream holes indicated with this icon:

### STEP 3

The lever from step 2 can be installed as shown.

The mechanism requires a 400mm (~1in) string.



String is not included in the activity pack (you will need to get some).

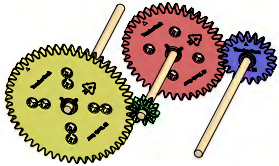
This end of the string should be tied to the lever.

This end of the string should have a loop to hook onto the stop clip.

Download the Mechanisms Guide at [TeacherGeek.com](http://TeacherGeek.com) to learn how this lever creates a mechanical advantage.

## GEARS\*

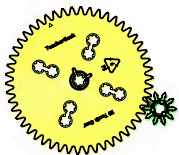
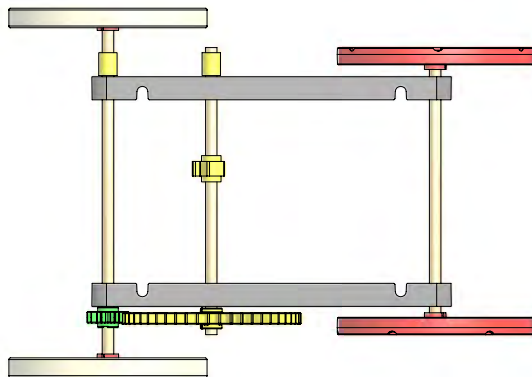
\*Gears are only included in the advanced rubber band racer pack.



A gear is a wheel with evenly spaced teeth around its perimeter. The teeth on multiple gears can mesh to form a gear train. Gear trains (meshing gears) can transmit force, create a mechanical advantage, and change the direction of force.

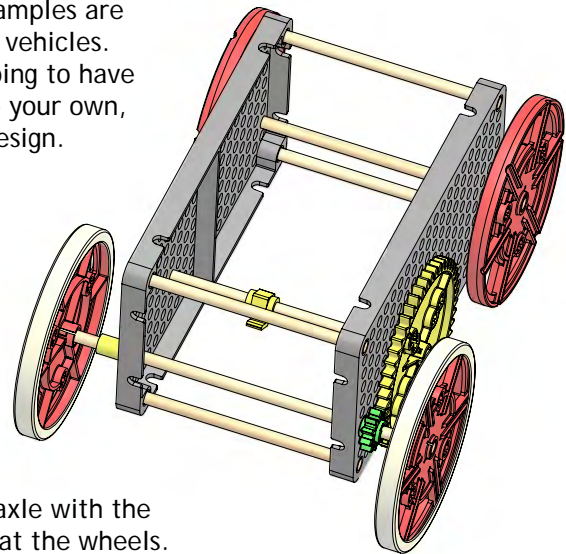
Download the TeacherGeek Mechanisms Guide to learn more about gear trains.

## GEAR TRAIN



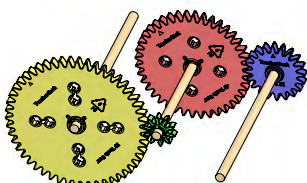
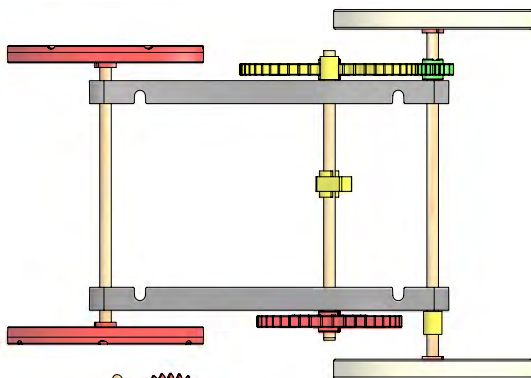
Large to Small

Note: Examples are not ideal vehicles. You're going to have to create your own, better, design.

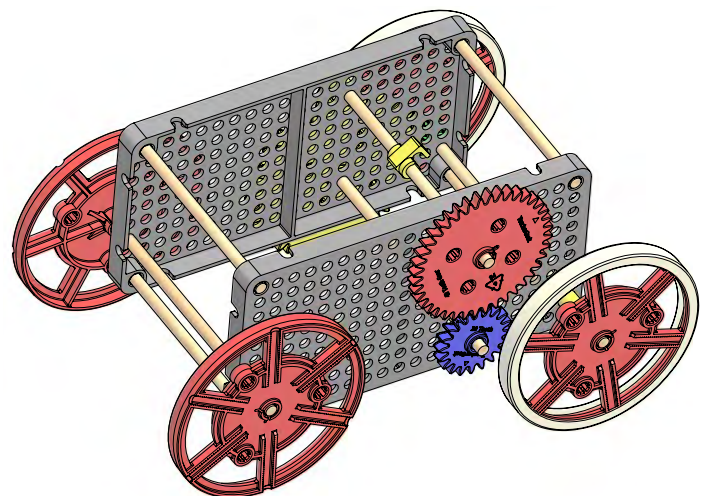


This gear train trades force at the axle with the stop clip for distance (revolutions) at the wheels.

## COMPOUND GEAR TRAIN



Large to Small, Large to Small



This gear train uses multiple gears to create a mechanical advantage greater than the 2 gear train. It is called a compound gear train.