

# Gears and Pulleys

## Pulleys

A pulley is a wheel driven by a motor. A belt is looped around this wheel and around a second wheel. When the motor is turned on, the powered wheel turns the belt which turns the second wheel.



This arrangement can be used to either increase power, increase speed and to change direction of motion.

**Increasing Speed:** When the powered pulley is larger than the non-powered pulley then the speed of the non-powered pulley is higher in proportion to the circumferences of the pulleys. If the powered pulley has a circumference of 4 and the non-powered pulley has a circumference of 2 then the non-powered pulley will be turning 2x as fast as the powered pulley: This is calculated by dividing the circumference of the powered pulley (4) by the circumference of the non-powered pulley (2). When you increase speed you decrease the power (torque – or ability to do work) of the system. The non-powered pulley is moving faster but it will not generate as much power.

**Increasing Power (torque):** When the powered pulley is smaller than the non-powered pulley then the speed of the non-powered pulley is slower in proportion to the circumferences of the pulleys. But the power in the 2nd pulley is increased proportionally. The non-powered pulley will move slower but it will be able to generate twice as much torque.

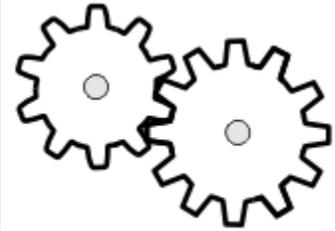
**Changing Direction:** You can change direction in a pulley system by looping the belt in a figure eight between the pulleys.

### Example of Pulley System

Pulley systems do not have to be assembled as accurately as geared systems but they are also subject to the belts slipping which can affect reliability of the system.

## Gears

**Spur gear:** With a gear system the wheels are in direct contact with each other. These are called spur gears. Gears require much more precise alignment than pulley systems. Gears can also be used to increase power or speed. Instead of using the circumferences of the gears to make the calculation you use the teeth count of the gears. If the powered gear has 20 teeth and the non-powered gear has 40 teeth then the gear ratio is 2:1. Motion of the non-powered gear is automatically reversed. If you need the gears to turn in the same direction then a gear called an idler gear is placed in between the two gears in the image. An idler gear does not increase power or speed – it simply changes direction of rotation. **Image: IdlerGear** **Video: Tamiya Gear Box**



**Worm Drive Gear:** Another type of gear is called a worm gear drive. The primary purpose of a worm drive is to increase power. A gear in the form of a screw (worm) meshes with a worm gear (similar to a spur gear). **Image: Worm Gear**

Worm gears are used for tuning mechanisms on many musical instruments such as guitars, violins and violas.

Worm gear ratios are expressed in terms of number of teeth in the worm gear to 1. Thus a worm gear drive with a worm gear that has 20 teeth would operate at a 20:1 gear ratio. Worm gear drives are much more compact than spur gears. To achieve a 20:1 ratio with spur gears the powered gear would need to have 20 teeth and the non-powered gear would have to have 400 teeth. This would be a very large gear. Tamiya sells a worm gear drive with gear ratios of 216:1 and 336:1

**Sprocket and Chain:** Another gear arrangement is a cross between a pulley system and a gear system. A sprocket is a wheel with teeth that mesh with a chain. The chain system on your bicycle is an example of a sprocket and chain system. An advantage of a sprocket and chain system is that it has some of the flexibility of assembly of a pulley system with the more reliable connection (no slippage) of a geared system.

**Finding Gears and Pulleys**

The biggest challenge for teams attempting to use gears or pulleys is finding gears and pulleys that will fit the motors they have elected to work with. One advantage to

using hobby kit motors is that most manufacturers have gear kits that are setup to work with their motors.

To find gears for other motors you will just have to search your garage, electronic surplus shops and the internet.

Possible sources for gears include: gears from "power wheels" type toys, and gears from other discarded appliances. Most surplus electronic stores (local or on-line) that sell motors also sell gears and gear boxes that may fit your motor.

Possible sources for pulleys include: hardware stores and discarded appliances.

**Source:** <http://tech.texasdi.org/gearsandpulleys>