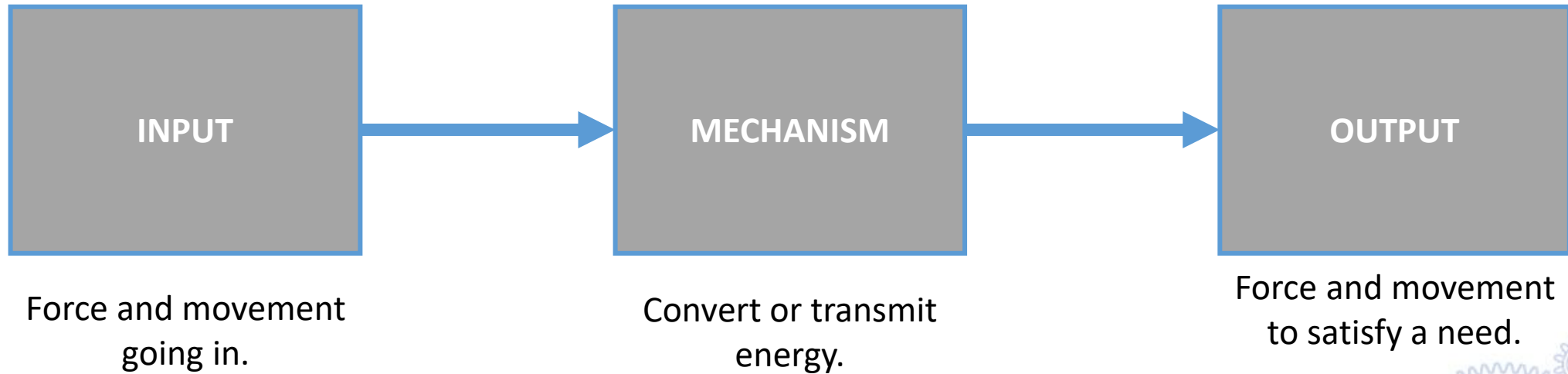




# VEX IQ Mechanisms Unit

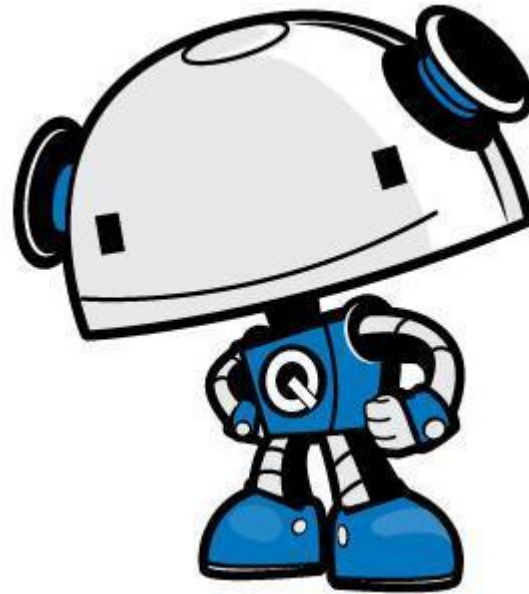
## Mechanisms & Types of Motion

# A simple block diagram



# Types of motion

- There are 4 types of motion.
- Mechanisms are used to convert, link and transfer motion.



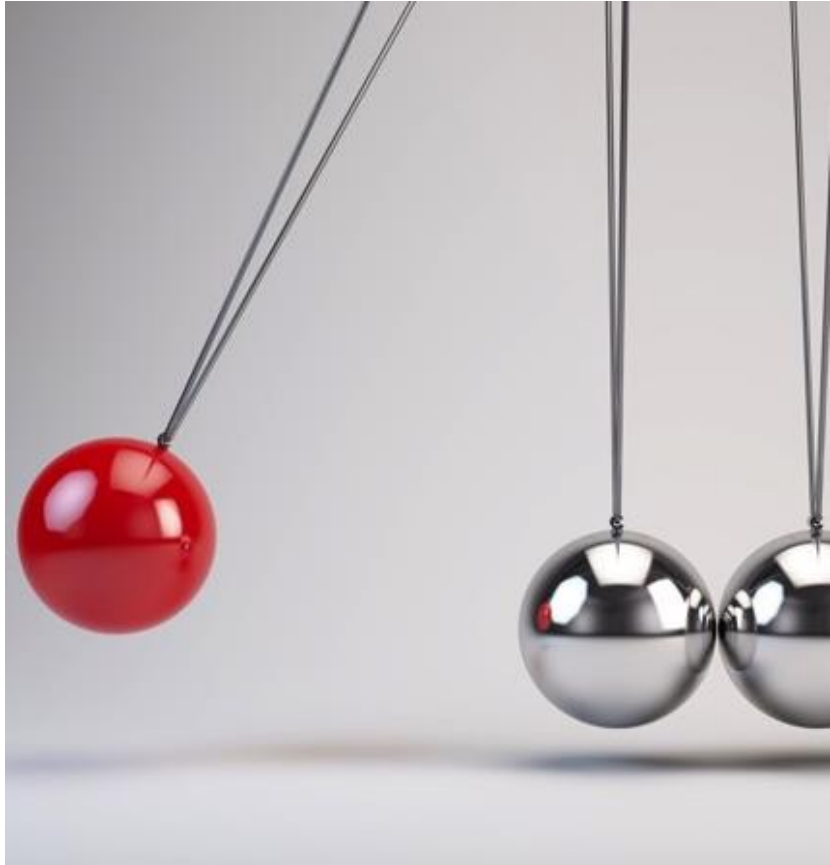
# Linear motion



- Motion along a straight line.



# Oscillating motion



- Repeated movement back and forth.



# Reciprocating motion



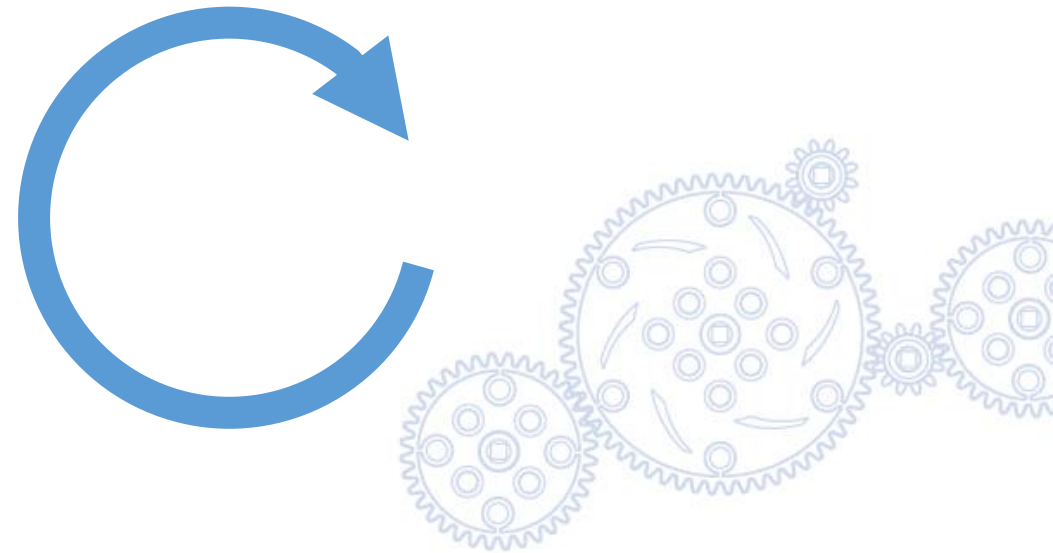
- Repetitive up-and-down or back-and-forth linear motion.



# Rotary motion

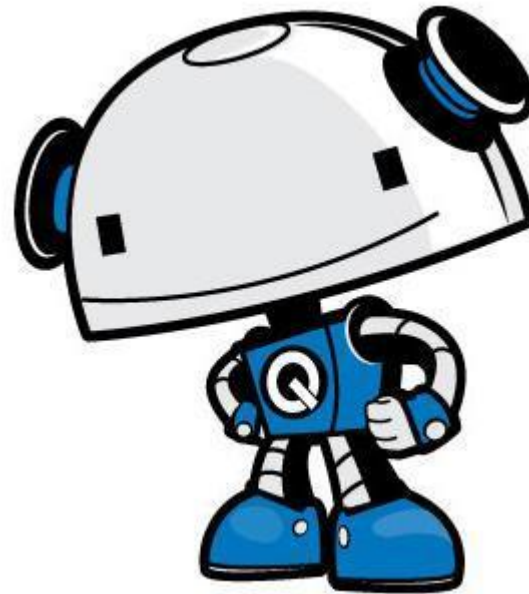


- Physical motion that happens when an object rotates or spins on an axis.



# Drive systems

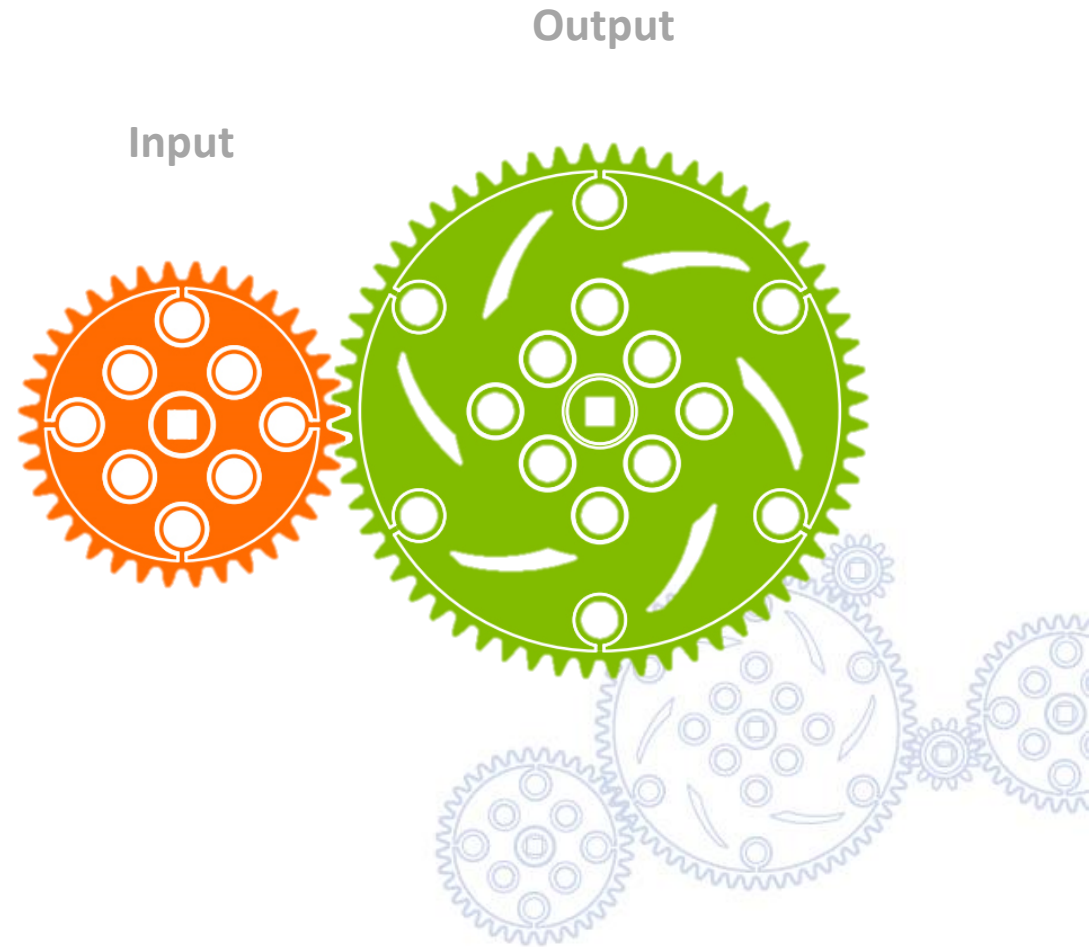
- We are now going to look at how we combine and transfer the 4 types of motion.
- These mechanisms are known as drive systems.





# Gear trains

- Two or more gears **mesh** with each other to **transmit rotational motion** from one shaft to another.
- The first gear in the train is known as the **input**.
- The final gear in the train is known as the **output**.

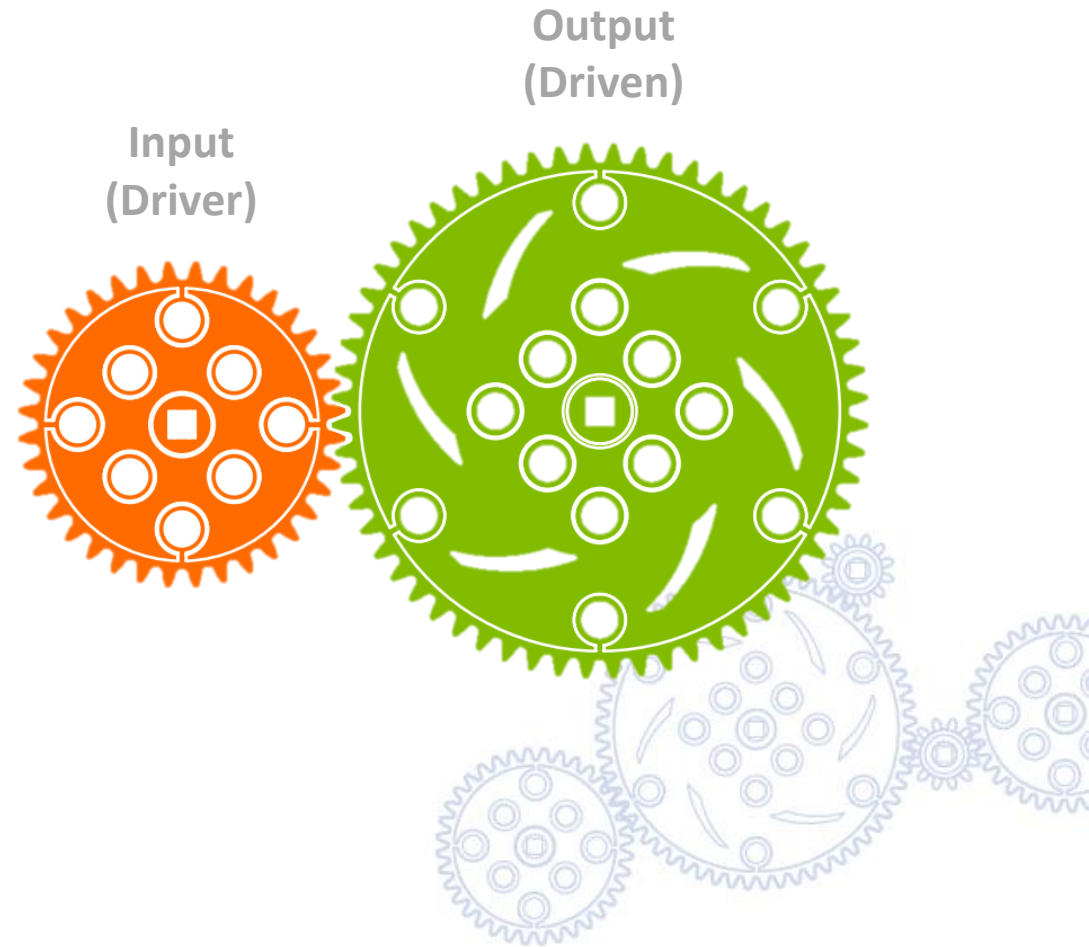


# Gear ratio

- Different sized gear wheels can be meshed with each other to either increase or decrease the speed of rotation.
- This “difference” can be expressed as a gear ratio.
- To calculate a gear ratio the following formula is used:

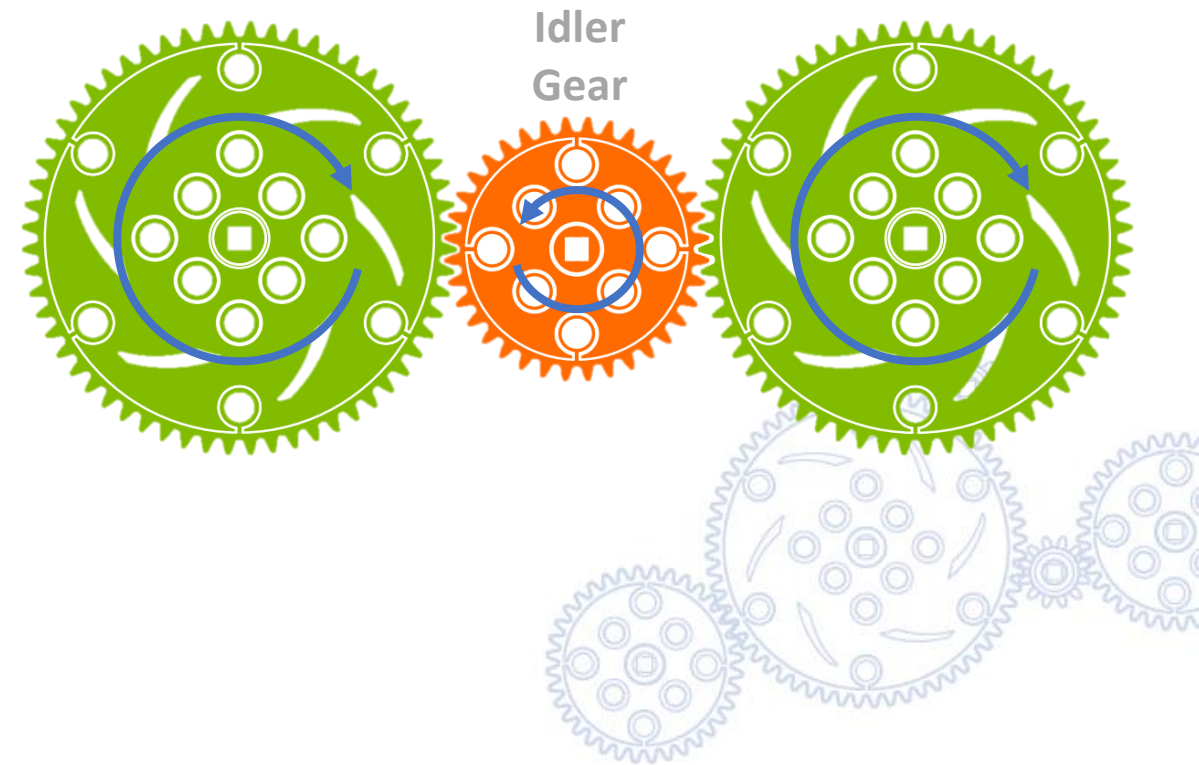
$$\text{Gear Ratio} = \frac{\text{Number of teeth on the driven gear}}{\text{Number of teeth on the driver gear}}$$

- The input gear is known as the driver gear.
- The output gear is known as the driven gear.



# Idler gears

- An idler gear is a gear wheel that is inserted between two or more other gear wheels.
- An idler gear can be used for two reasons:
  1. The idler gear will change the direction of rotation of the output shaft. Meaning the two shafts either side of it will rotate in the same direction.
  2. An idler gear can be used to increase/decrease the spacing between two shafts that are required to rotate in the same direction.



# Compound gears

- Compound gears are gear wheels that are “**stacked**” on top of each other to share the same axle.
- Compound gear trains are great if you need to transfer rotational motion in a tight space.
- Ideal if you need to transfer and adjust the speed of rotational motion from one shaft to another in a relatively small area.



# Compound gear examples



Watch Mechanism



Motor Gearbox



# Bevel gears

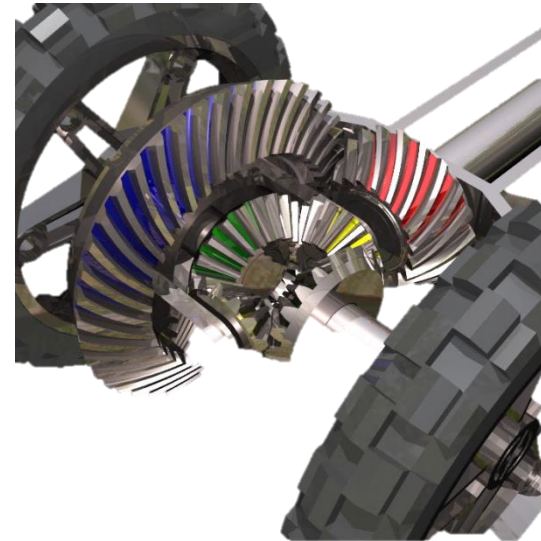
- Bevel gears have a **cone shape** which enables them to mesh at various angles.
- The teeth of a bevel gear can be straight cut, similar to those of a spur gear, or they can be curved along their length with each tooth at an angle (spiral/helical bevel gear).



# Bevel gear examples



Manual Hand Drill



Differential Gearbox



# Crown gears

- Crown gears are a form of bevel gear.
- The teeth of crown gears **project at right angles** to the plane of the wheel.
- Crown gears are usually meshed with another bevel gear, but in some instances are meshed with spur gears.





# Crown gear example

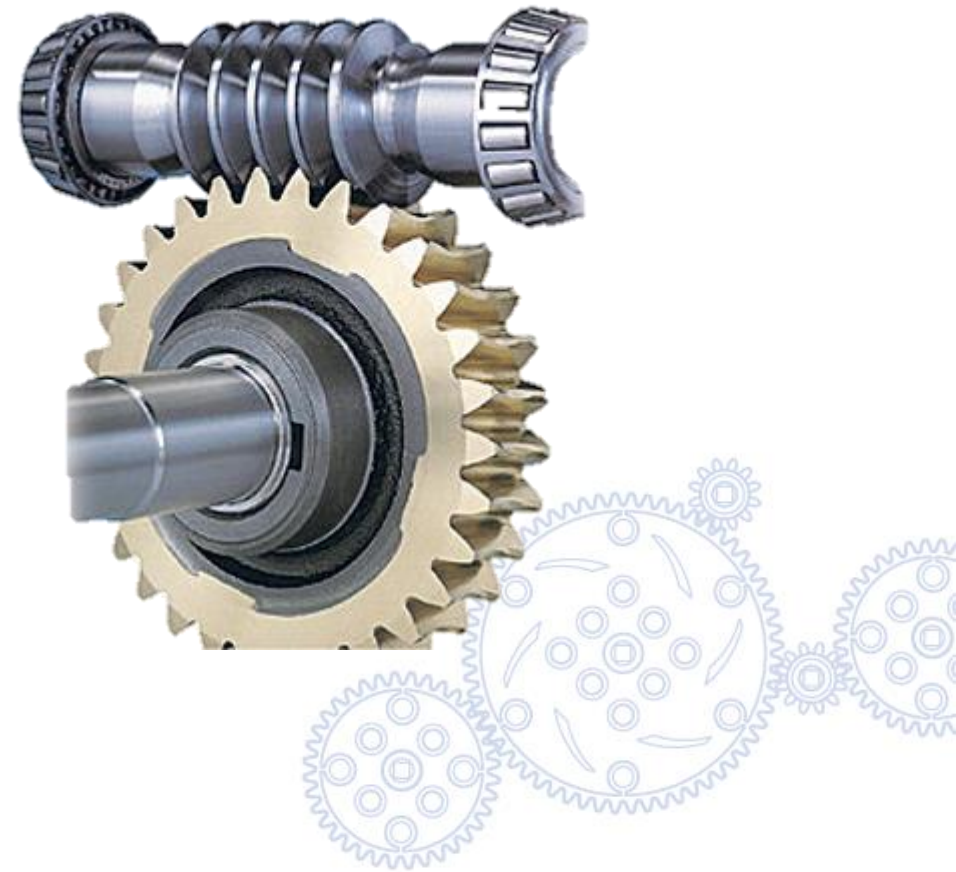


Spinning Roller Coaster Cars



# Worm gears

- The **worm** resembles the thread of a screw and is usually meshed with a worm wheel or a typical spur gear.
- Worm gears are an excellent way to **increase torque** output whilst reducing rotational speed.
- Worm gears do have a slight disadvantage in that they are **not very efficient**, a lot of energy can be wasted due to the sliding action of the gear teeth.



# Worm gear examples



Winch Mechanism



High Torque Motor Drives

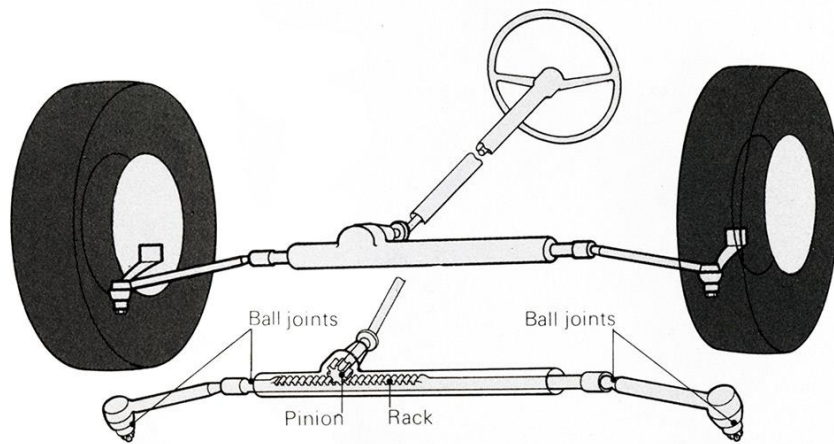


# Rack and pinion

- A rack and pinion converts **rotational** motion into **linear** motion.
- A circular gear wheel called “**the pinion**” engages teeth on a linear gear bar called “**the rack**”.
- Rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.



# Rack and pinion examples



Car Steering

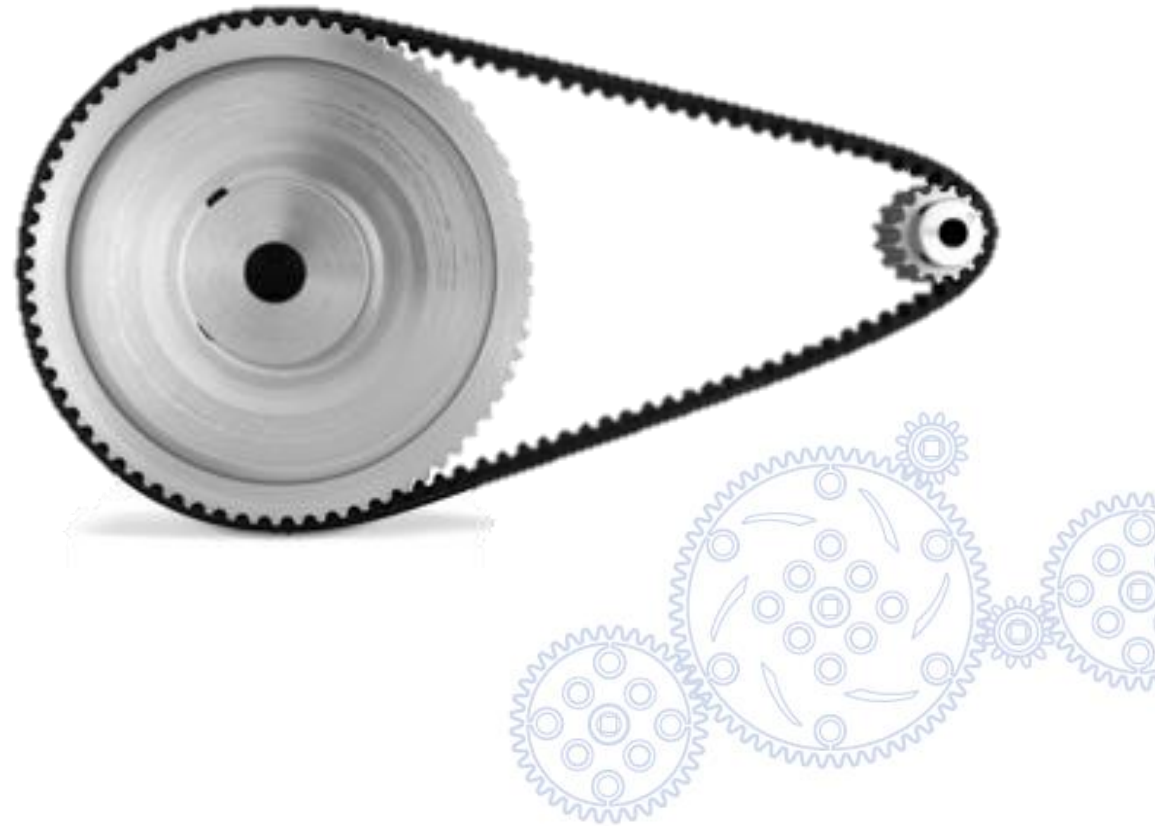


Uphill Traditional  
Train Tracks



# Belt and pulley

- Pulleys can be used to change the speed and direction of rotation, turning force or torque.
- A pulley system consists of two **pulley wheels**, each on a shaft and **connected by a belt**.
- There are different types of belt:
  - Smooth/straight
  - V Belt
  - Toothed Belt



# Belt and pulley examples



Motorcycles



Pillar Drill



# Chain and sprocket

- A sprocket or sprocket-wheel is a profiled wheel with **teeth, cogs**, or even **sprockets** that mesh with a chain, track or other perforated or indented material.
- The name 'sprocket' applies generally to any wheel upon which radial projections **engage a chain** passing over it.
- It is distinguishable from a gear as sprockets are **never meshed together directly**.
- A sprocket differs from a pulley because sprockets have teeth and pulleys are smooth.





# Chain and sprocket examples



Bicycles



Tank Tracks



# Universal joint

- A universal joint is a **mechanical device** that allows one or more rotating shafts to be linked together, allowing the transmission of torque and/or rotary motion.
- It also allows for transmission of power **between two points that are not in line** with each other
- It consists of a pair of hinges located close together, oriented at  $90^\circ$  to each other and connected by a cross shaft.
- The universal joint is **not a constant-velocity** joint.

