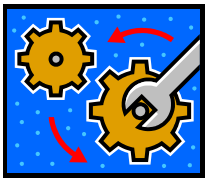
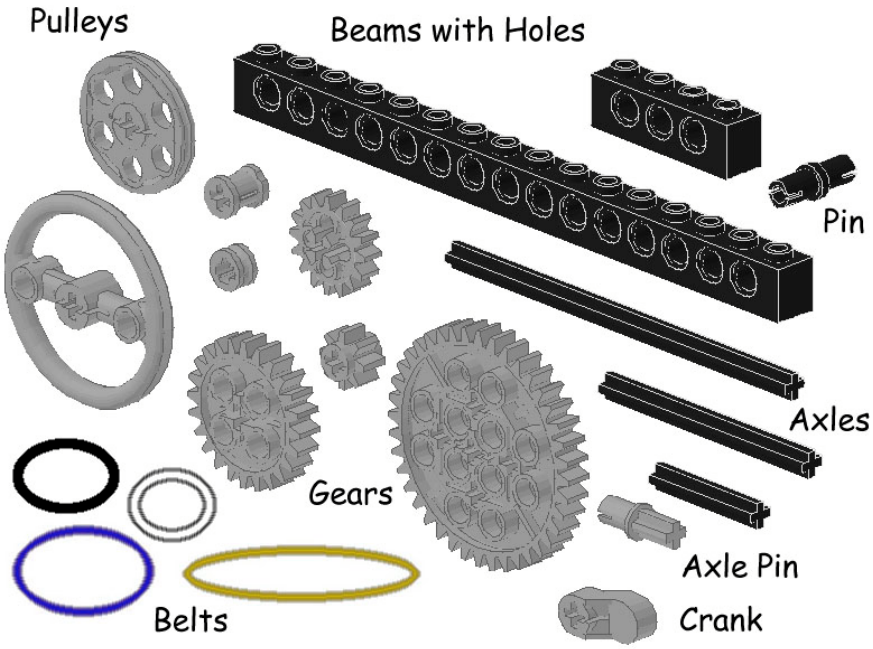
Gears and Pulleys



Use parts in your LEGO™ set to build a machine that uses gears or pulleys. Here are some of the kinds of parts you might use:



RULES: Build one of the examples you see from the Gears and Pulleys handout.

What is a name for the gear or pulley combination(s) you used? (see the handout)

Did you use gears or pulleys or both?

Do all of the gears or pulleys in your machine turn at the same speed?

How many gears does your machine have?

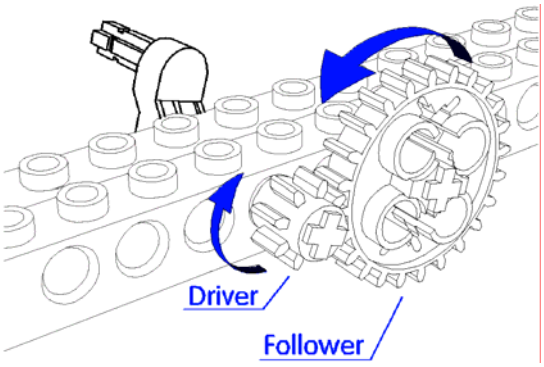
How many pulleys does your machine have?

How many axles does your machine have?

Draw a picture of your machine:

If you have time, build another machine using Gears and/or Pulleys.

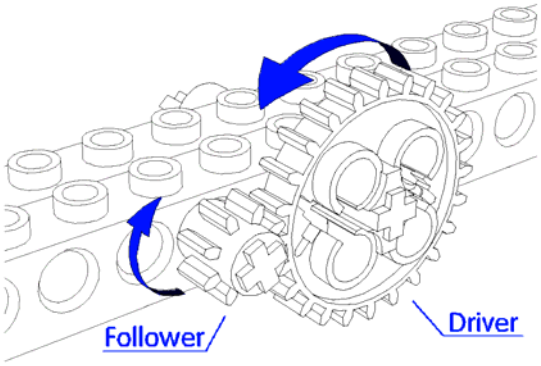
1. Gearing Down



Main Idea:
If you use a small gear to drive a large gear, the large one will turn slower.

Additional Information:
Here we see a small driver gear and a large follower. It's really hard to make a gear like the big one turn - we'd have to use a lot of force. But with a smaller gear, we can use a process called gearing down to help us out. Gearing down decreases speed but increases force. Since it's easy to turn a small gear at a fast speed, we use it to move the large one. A small driver gear makes a large follower gear turn more slowly. For this model, five turns of the 8-tooth driver produce one turn of the 40-tooth follower. This ratio of 5:1 is called the gearing down ratio.

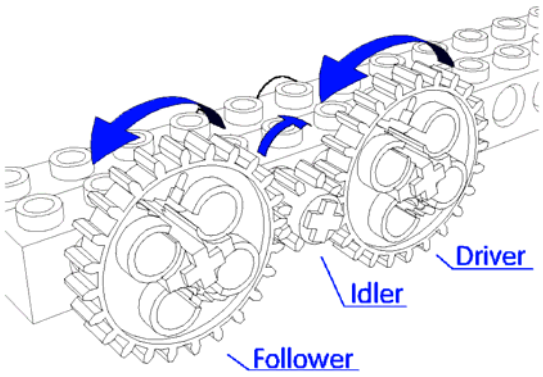
2. Gearing Up



Main Idea:
If you use a large gear to drive a small gear, the small one will turn faster.

Additional Information:
Here we see a large driver gear and a small follower. We can move the small gear pretty fast on our own, but we can use a process called gearing up to move it even faster. Gearing up increases speed, but decreases force. A good example of a gearing-up system in real life is a 10-speed bike - when you shift into 10th gear, you turn a large gear with the pedals, which drives a small gear attached to the rear wheel. For this model, one turn of the 40-tooth driver produce five turns of the 8-tooth follower. This ratio of 1:5 is called the gearing up ratio.

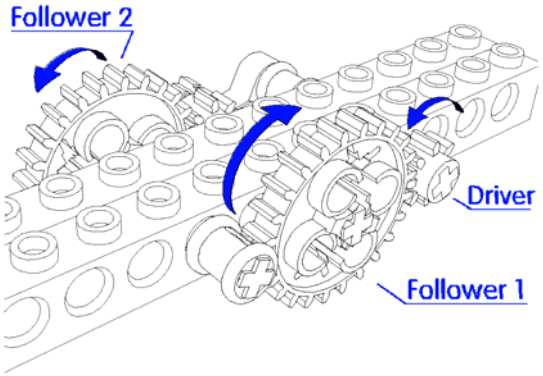
3. Idler Gearing



Main Idea:
An idler gear is used to make a driver gear and a follower gear turn in the same direction.

Additional Information:
Sometimes you need to have gears turn in the same direction. Since a driver gear and a follower gear turn in opposite directions, an idler gear is placed in between the two gears. The idler gear rotates in the opposite direction as the driver gear, and the follower gear rotates in the opposite direction of the idler - i.e. the same direction as the driver!

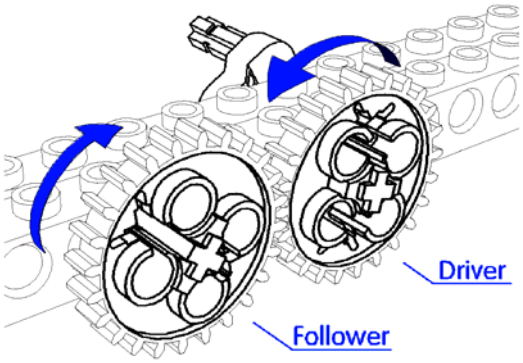
4. Compound Gearing



Main Idea:
Gears of different sizes on the same axle can be connected to other gears to build more extensive gearing down (and gearing up) arrangements.

Additional Information:
Compound gearing gives you the ability to use even more force by adding more gears to the arrangement. You can connect more gears on the same axle to build more complicated arrangements. In this model, we see two separate 5:1 gearing down arrangements, connected to each other by the axle passing through the first 40-tooth gear and the second 8-tooth gear. The first 40-tooth gear turns slowly. The second 40-tooth gear turns even slower. This connection increases the gearing down ratio to 25:1.

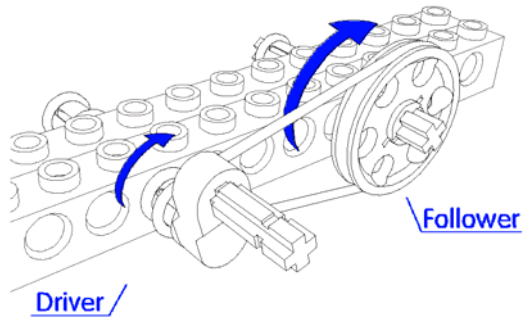
5. Direction of Rotation



Main Idea:
Two gears which are meshed together turn in opposite directions.

Additional Information:
Here we see two gears meshed together. When you mesh two gears, turning the driver gear makes the follower gear turn in the opposite direction.

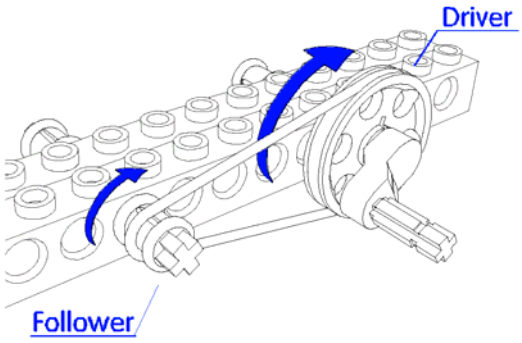
6. Decreasing Pulley Speed



Main Idea:
If you use a small pulley wheel to drive a large pulley wheel, the large one will turn slower.

Additional Information:
With this model, we have a pulley with a small driver wheel and a large follower wheel. It's really hard to make a wheel like the big one turn - it would take a lot of force. But with a smaller wheel, we can use a process called gearing down to help. Gearing down decreases speed but increases force. Since it's easy to turn a small wheel at a fast speed, we use it to move the large one. A small driver wheel makes a large follower wheel turn more slowly. Since this is a pulley model, both wheels turn in the same direction.

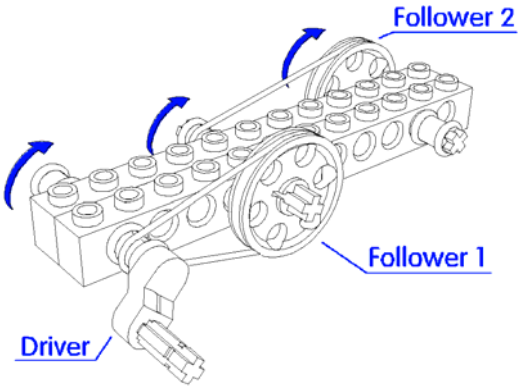
7. Increasing Pulley Speed



Main Idea:
If you use a large pulley wheel to drive a small pulley wheel, the small one will turn faster.

Additional Information:
In this pulley model we have a large driver wheel and a small follower. We can move the small wheel pretty fast on our own, but these pulleys use a process called gearing up to move it even faster. Gearing up increases speed, but decreases force. A large driver wheel makes a small follower wheel turn faster. However, unlike gears, in this pulley model both wheels turn in the same direction.

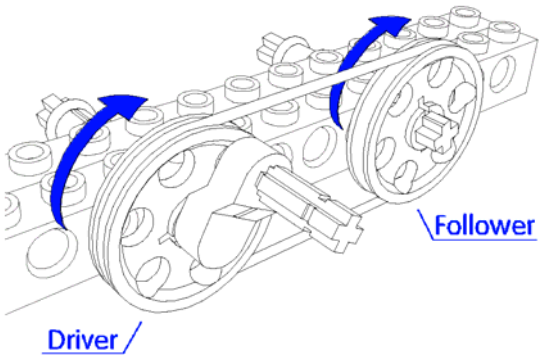
8. Compound Belt Drives



Main Idea:
Pulley wheels of two different sizes on the same axle can be connected to other pulley wheels to build more extensive gearing down (and gearing up) arrangements.

Additional Information:
If you need to have even more force or speed than you can get from a two-pulley arrangement, you can combine pulleys and belt drives to create a more extensive gearing combination. In this model, we see another axle and pulley added to gear down to an even greater extent. The first follower wheel turns slowly - the second turns even slower. You can also build larger gearing up arrangements.

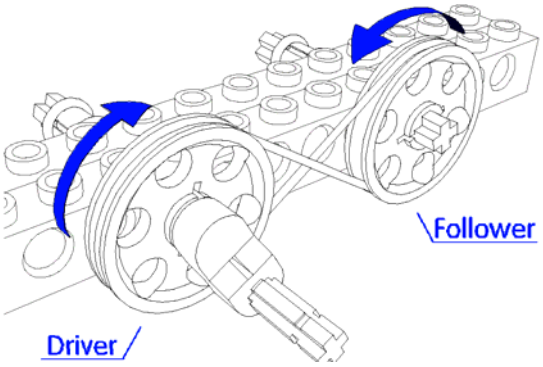
9. Direction of Pulley Rotation



Main Idea:
Two pulleys connected by a belt turn in the same direction.

Additional Information:
Here we see two wheels connected by a belt. When you turn the driver wheel, the belt causes the follower wheel to turn. This is a pulley system. The two pulley wheels connected this way will turn in the same direction. As in any pulley model, the belt has a small amount of slippage, which keeps the belt loose so it won't break if the wheels are forced to stop.

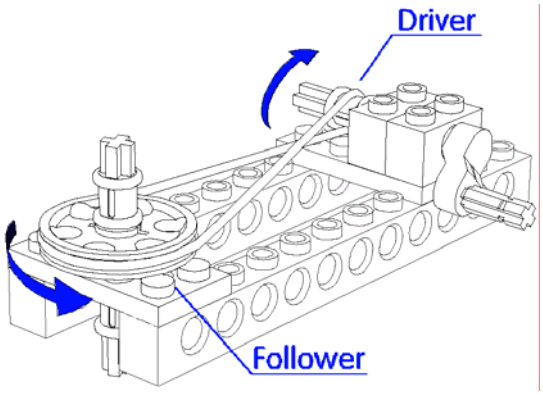
10. Changing Direction of Pulley Rotation



Main Idea:
Two pulleys connected by a crossed belt turn in opposite directions.

Additional Information:
Two pulleys connected by a straight belt turn in the same direction. If you want the pulleys to turn in opposite directions, you have to cross the belt and make a figure-eight shape. In this model, the belt is crossed so the driver and follower pulleys turn in opposite directions. As in any pulley model, the belt has a small amount of slippage, which keeps the belt loose so it won't break if the wheels are forced to stop.

11. Pulleys At An Angle



Main Idea:
A belt drive can be used to change the direction of rotation by 90 degrees.

Additional Information:
If you need to change the direction that an axle is facing, you can place your pulley at an angle. In this model, the driver gear is at a 90 degree angle to the follower. The direction of rotation changes 90 degrees when the driver is turned. The driver pulley and the follower both turn in the same direction. This model also shows a gearing down arrangement, as the driver pulley is smaller than the follower.

Adapted from information on http://www.lego.com/constructopedia/