

Aim

To investigate the relationship between speed of a wheel and the number of teeth on each gear connected to it?

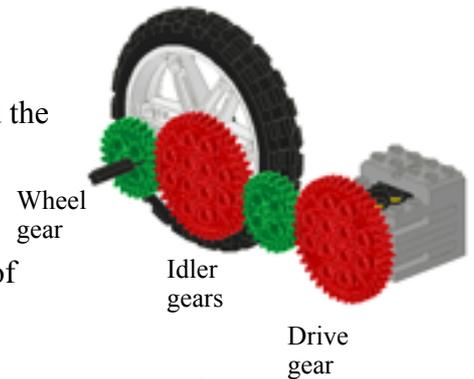
Discussion

The size of a gear wheel is obviously related to the number of teeth when all teeth are the same size.

Big gears have more teeth.

When different gears mesh, the distance each moves is related to the gears size. The teeth mesh one at a time. So a 10 tooth gear would turn four times meshed with a 40 tooth gear, that turns once.

So if a motor is connected to the 40 tooth gear and a wheel connected to the 10 tooth gear then the wheel would turn four times as fast.



By setting up the data logging software to read the sensors or even reading the two sensors on the screen the speed ratio can be calculated:

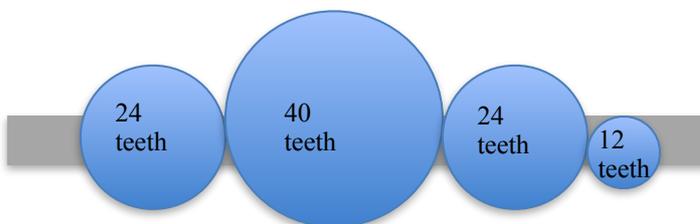
$$Speedratio = \frac{Wheel\ angle\ moved}{Motor\ angle\ moved}$$

For any length of time this ratio should be constant?

Experiment using LEGO Technics or Mindstorms

Construction

1. Build a gear train using a Lego Beam, small axles and 4 gears as shown in the diagram below:



Gear # **1.** **2.** **3.** **4.**

2. You can measure the movement of the gears using a winch handle connected to gear 1 and adding a wheel in succession to gear 2, 3 and 4. or Data Log two motors. See Next page.

Data Logging using LEGO Mindstorms or EV3

1. Connect two motors ; motor A and Motor C to their respective motor ports on your LEGO Brick (EV3 or NXT)
2. Connect your Brick to the computer
3. Connect up the two motors to your gear train so that:
Motor A is attached to gear 1. Motor C is attached to gear 2.

(See photos of sample LEGO gear trains on following pages)

NXT and EV3 motors have rotation sensors built in.

By connecting the motor to the axle, you can determine how much a wheel moves in a certain time.

Using two motors, would mean you could measure the motor axle and the wheel axle at the same time. Motor A is powered to drive the Gear Train. Motor C is left unpowered.

Procedure

- First count the teeth on each of the gears along the train and record the ratio of $\frac{\text{No of teeth of Motor gear}}{\text{No of teeth of wheel gear}}$
- Write a program to:
 1. reset the two motor rotation sensors on ports A and C
 2. set up data logging two motor rotation sensors measuring degrees and running for 5 seconds at a rate of 10 samples per second
 3. power motor A for 5 seconds.
 4. Stop datalogging
- Download the program to your Brick
- Run the program making sure the gear train is held steady so that the wheels can rotate evenly.
- When completed use the data logging screen to upload the graph of results.
- Read the values of the Y axes at various times (1, 2, 3, 4 and 5s) and record the angles in the table.
- Now move the wheel sensor to a different gear along the train and repeat the experiment.
- Continue until all gears are tested.

Observations

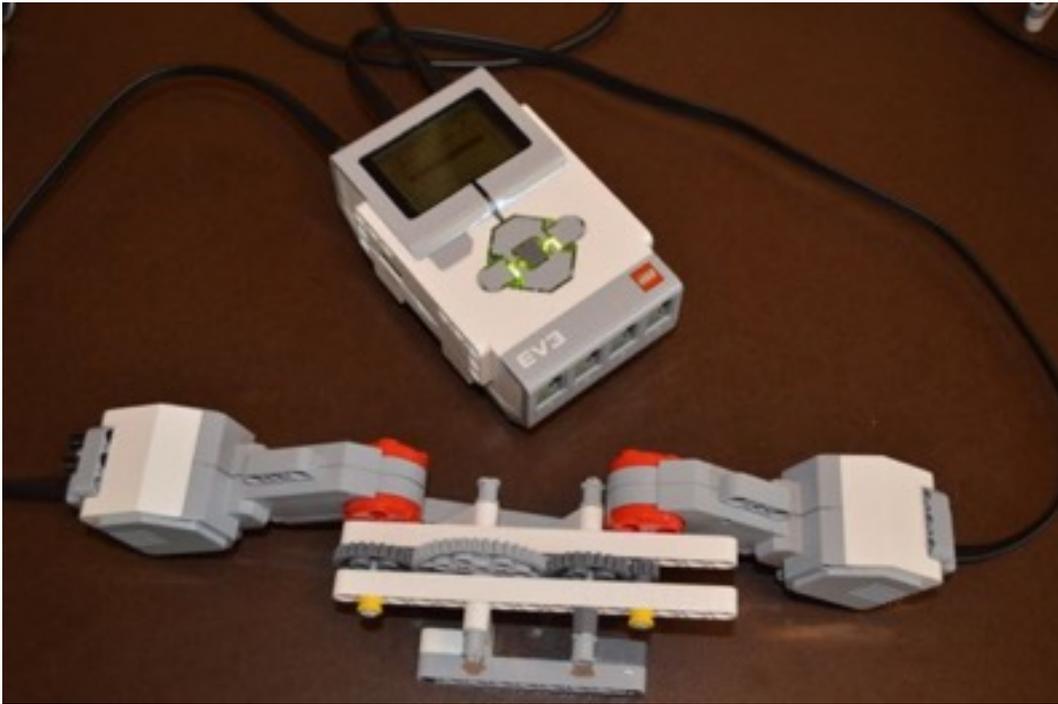
Motor Gear #	Wheel Gear #	Ratio: No of teeth of Motor gear divide by No of teeth of wheel gear	Time	Angle of motor gear	Angle of wheel gear	Ratio: <u>motor angle</u> / <u>wheel angle</u>
1	2		1s			
			2s			
			3s			
			4s			
			5s			
1	3		1s			
			2s			
			3s			
			4s			
			5s			
1	4		1s			
			2s			
			3s			
			4s			
			5s			

Analysis

1. Which gears go further? (small/big)
2. Is the angle ratio a constant no matter what the time?
3. Compare the no of teeth ratio, to the angle ratio from the table.
How are they alike?
4. Does the type of gears in the middle have any effect on the angle ratio of the first and last gears?
5. If you want to speed up a car what size gear would you have on the motor and what size on the wheel?

2. EV3 Version of Lego Mindstorms

Set Up



Sample Program



Sample Graphs

