BIKE WORKS

Experimenting with Bicycle Gears

Reading

The gears on a bicycle help make life a lot easier on cyclists, particularly in a city like Seattle! The main advantage is that multiple gears allow a rider to adjust to different road conditions and road inclines by making pedaling easier or harder (depending on what the rider is looking for in each situation). If you have ever ridden up a big hill you know that shifting gears is a must for easier hill climbing. This lesson will be about gear systems and how they work to make the bicycle a versatile vehicle that can take on almost any type of terrain. The real life results of using different gears is something that is easily noticeable to a rider and you will learn here how those real life qualities relate to the physics behind a gear system.

Perhaps, if you are regularly biking around town, you have noticed the following:

- A group of riders come to a stop at a stoplight and when the light turns green, they all head off in the same direction down the same street
- Most of the riders will appear to all be in the same gear range and will start off very leisurely at a fast pace
- But one rider is in a harder gear, standing on the pedals and struggling to turn them at the start of the green light
- If this occurs, you would see that at the other end of the street the group of riders will be ahead of the lone rider who had chosen a harder gear to start
- But after about another 30 seconds, that lone rider would pass by quickly, pedaling easily and outdistancing the others who have stayed in that easier gear

Why do you think this would happen? Maybe they all just get tired after the first minute and stop trying? That is possible, but more likely it has to do a lot more with the difference in gear choices. Hopefully by the end of this segment you will understand the physics behind why this happens.

In this lesson you will be exploring using different combinations of gears and their effects on the ease of pedaling and the speed of a bike. Since this lesson involves learning about the real life characteristics of different gears, it doesn't need much introduction. All you need is a bike with gears, an inquiring mind, and your legs!

EXPERIMENT

Materials: Bike with Gears
Stopwatch
Notebook
Partner

Acceleration Race:

- Find a decent working and shifting road bike that has multiple gears and find a stopwatch with precise timing for your partner to time you with
- Go outside with a partner and find a street where you can ride a fair distance without much interference from cars.
- Find two markers on the road (signs, rocks, driveways, make your own lines with chalk) that are separated by about the distance of a normal stoplight intersection.
- Put the bike in the high gear (largest chainring) on the front and the low gear on the back (largest cog closest to the hub).
- Come to a complete stop at one of the landmarks and get ready to race towards the other one.
- Have your partner wait at the other landmark with the stopwatch.
- Have your partner say "1-2-3 Go!" and start the stopwatch when they say "Go!".
- Race as fast as you can to the other landmark and have your partner stop the watch as soon as you cross the second landmark.
- Write down the time it took next to the combination of gears used. You will have to make up a good method of naming the gears by using numbers that you can duplicate in future experiments.
- Repeat this process using many different combinations of gears: put the gears in the opposite configuration than the first one; try a combination in the middle of the gears.
- Try multiple variations and then find and record the gear combination that allows you to get to the other landmark the fastest and the gear combo that gets you there the slowest (remember to always try your hardest to get there in order to keep the experiment valid).

Experimenting on a Stand:

- Put the same bike on a bike stand/hang it by the saddle so that you can easily see the gears and can turn the crank arms with the back wheel rolling in the air.
- Using the same gear combo you started with outside, grab the drive-side pedal (the one with the gears on the same side of the bike) and turn the cranks clockwise one rotation over a period of 2 seconds (you can count "one-mississippi two-mississippi") and then let go and let the rear wheel spin freely.
- Try and gauge the speed of the wheel. Find and record the gear combo that moves the wheel the fastest and the one that moves it the slowest.

- Now squeeze onto the brakes so the brake pad is engaged with the rim of the rear wheel like you are trying to stop the bike. Try to find a gear that still allows you to pedal forward with the least resistance.
- Using different gear combos, find and record the combo that makes it the easiest and the hardest to move the cranks while your hand is engaging the brakes.
- What does this say about the amount of force that is being applied to the wheel for each combination?

QUESTIONS

1) Based on what you have learned from your experiments, which gear combination would you choose to use for moving very fast on level pavement and why?

2) Based on what you have learned from your experiments, which gear combination would you want to use for climbing a very steep hill and why? (think about how much extra force is needed to climb a hill)

3) SPOILER ALERT: Can you explain why the highest gear combination (largest chain ring- smallest cog) gives the fastest motion of the wheel in the stand but gets you the slowest time between the two landmarks outside?

If you want to send in your experiment findings for a cool prize email us at: programs@bikeworks.org