Day 4: Gears

Introduction: What would happen if for every turn of your pedals, the bike tire went around only once? It would be very hard to go fast or slow down or up hills. That's how the earliest bikes used to be, and the bicycle gearing system made it possible to turn the wheel fewer or more times than your feet pushing the pedals around. By changing the distance that the bike goes with one revolution of the pedals, it becomes possible to go at a high cadence (cycles per minute) up hills and lower cadence on flats or downhill for greater efficiency.

Information: Gears

How Gears Work:

One gear with a certain number of **teeth** or **cogs** is in contact with another (can be direct contact or through a chain as in the case of the bike). One gear is turned (on a crank or by pedaling) and because the two are connected but are different sizes, the other gear turns at a different **rate** (faster or slower). The gear that is manually turned is called the **drive gear**. The other gear is connected to a wheel or axle that needs to be turned, and it is called the **driven gear**.

Gears on a bike:

Chain Wheel

- Front of Bike
- Connected directly to pedal
- Two to three gears

Freewheel

- Back of Bike
- Connected directly to rear wheel
- Between five and nine gears

Gear Ratios:

A gear ratio is a set of two numbers that tells us how fast one gear will spin in relation to another when they are connected. A gear ratio is a function of how big each gear is.

To calculate a gear ratio, count the number of teeth on the drive gear and divide it by the number of teeth on the driven gear.

Ex. 1) The drive gear has 60 teeth and it is connected to a driven gear with 20 teeth
Divide 60 by 20, and you get three, so the gear ratio is 3:1 pronounced "three to one."

Ex. 2) The chain wheel on a bike (front gear connected to the pedals) has 50 cogs and is connected by a bicycle chain to a freewheel (rear gear connected to wheel) with 10 cogs
Divide 50 by 10, and you get 5, so the gear ratio is 5:1.

How do gear ratios relate to how many times we pedal per revolution of tire? Bikes are rear wheel drive, as we mentioned earlier. For the first example, say you pedal three times around so that the chain wheel gear goes around one time. Since the gear ratio is 3 to 1, the back gear (freewheel) will go around one time because the two are connected. This means that for every three revolutions of the pedal, the wheel will turn one time. This would be good for going up a hill. If the ratio were 1 to 5, for each pedal turn the bike would go five wheel lengths, which would be good for going down hill.

Gearing Up: Higher Gear Ratio

- High Gear Ratio: more gears on front than back (ex. 3:1 or 5:1 ratio)
- Must pedal a bunch of times in order for the wheel to make one complete revolution
- Don't go very far on one pedal
- Good up hill

Gearing Down: Lower Gear Ratio

- Low Gear Ratio: fewer gears in front than back (ex. 1:4 or 1:6)
- For each pedal, rear wheel turns a lot
- Can go far on just one pedal
- Good for flats and downhill

Activity: Gear Up or Gear Down???

What would you do in the following circumstances… gear up or down?

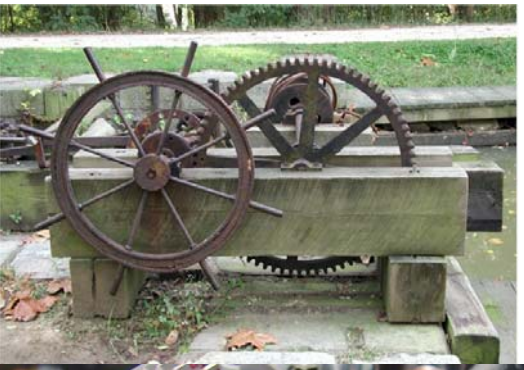
Activity: Real Bike Gears

Activity: Gears in Odd Places

What everyday objects do these gears come from?

Clock: Gears in a clock allow for different hands to turn at different times based on the size of the gears that they are connected to.

Model car motor: Gears are typically attached to motors so that the drive gear (turned by the motor itself) can turn something else at a different rate.



Drawbridge: In the olden days, gears were attached to cranks for heavy lifting with high gear ratios, so that with each turn of the wheel, the driven gear only turned a fraction of the way around. This way it was easier to turn the wheel than actually lifting the drawbridge.

Car: Ever heard of shifting a car? Well, when your car shifts into first, second or third gear, you are using actual gears to change the gear ratio so that it is more efficient for your car to go at a certain speed. You gear up and down to go up and down hills in a car just as you do for a bike.

Information: **(Extention) Cadence** – Rate of Pedaling (# of pedals or cycles per minute)

- High Cadence (fast), Geared Up (easy to pedal)
- Low Cadence (slow), Geared Down (hard to pedal)
- Finding the Balance
    - Efficiency: How to use the body's energy in the most effective way
    - How to go the furthest distance while expending the least amount of energy
    - Most bikers pedal too slowly, using too much energy at higher gears

Conclusion: Gears are a simple machine that helps perform a variety of functions in many everyday objects, especially bikes. They are one of the many ways that engineers have created a way to make things more efficient for people to complete their everyday tasks.

Massachusetts Standards: Grade 3-5, Materials, tools and machines, 1.3: Identify and explain the difference between simple and complex machines, e.g., hand can opener that includes multiple gears, wheel, wedge gear, and lever.