IT LOOKS COOL BUT HOW DO I MAKE IT MOVE?

DRAG- the sum of all areodynamic or hydrodynamic forces that oppose the motion of the object thru the air or water. In a powered vehicle it is overcome by thrust.

FRICTION- the force that opposes relative motion of surfaces in contact with each other.

GRAVITY- the tendency of objects with mass to accelerate toward each other. The force that pulls objects toward the center of the earth.

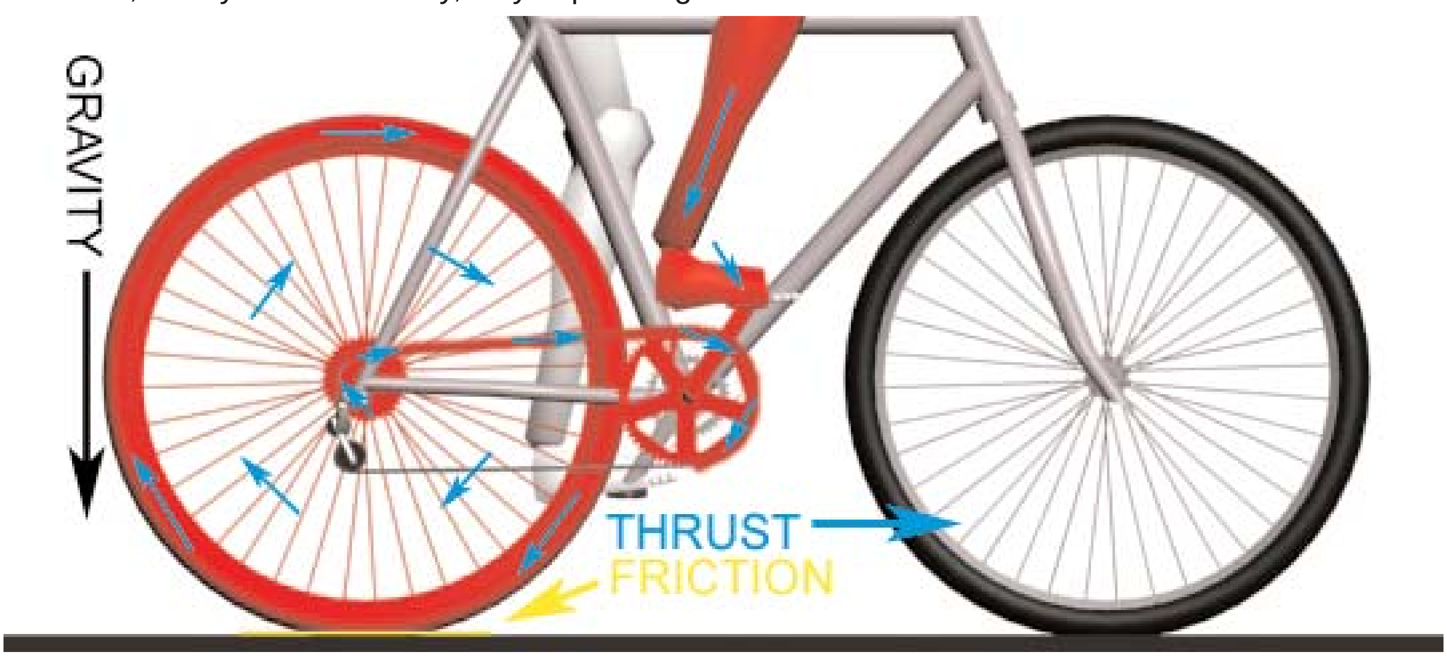
THRUST-force in a forward direction

MOMENTUM- the tendency for an object to continue to move in its direction of travel

There are many ways to make a kinetic sculpture move along the course. They can walk, could fly but most roll and usually on wheels. For each you need to figure out what's going to make the vehicle move and what wants to keep it from moving. **Thrust** and **gravity** will make the vehicle move. **Momentum** will help keep it moving (or stopped). **Drag**, **friction**, and **gravity** (gravity…you traitor!) will resist movement and slow or stop the vehicle. **Friction** does help produce traction.

CREATING THRUST

To create thrust for a vehicle that rolls you have to figure a way to make the wheels rotate. The most common, but by no means only, way is pedaling.



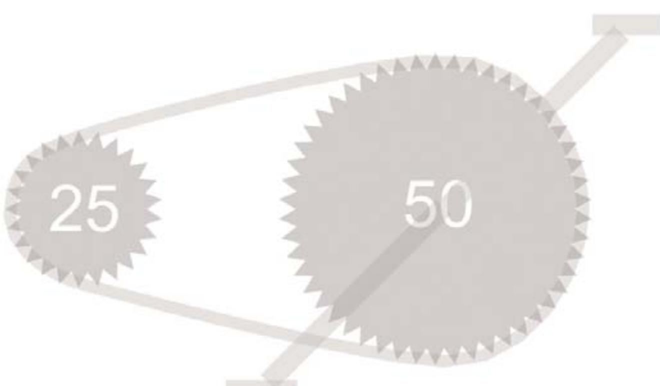
When you pedal the force transfers thru the **crank arms** to the **front chain ring**. The **chain** is pulled forward by the **teeth** on the top side of the **chain ring**. All of the force is transferred on the top half of the **chain** loop. The bottom half only returns the chain to the **rear cassette** to be pulled forward again. When the **rear cassette** is pulled by the **chain** the force is transferred thru the **hub**, up the **spokes** to the **rim** and **tire**. It is the point where the tire hits the road that **thrust** is created. **Gravity** holds the tire against the road and **friction** keeps it from spinning in place.

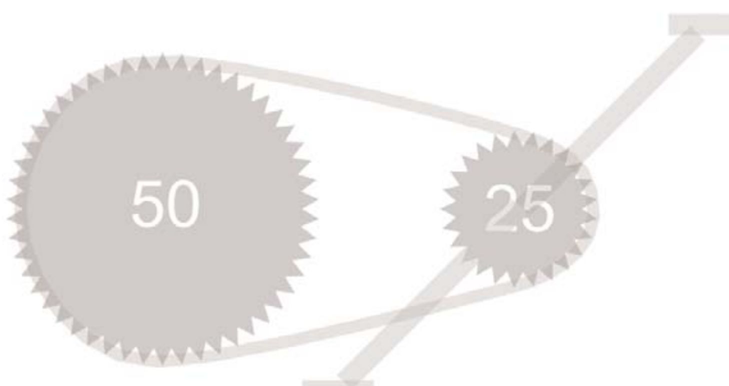
GRAVITY & FRICTION

When the bike encounters inclined, slippery, or loose surfaces it is critical that the weight be over the drive wheel. If too much of the weight on a bike is over the front wheel, **gravity** will fail to hold the rear wheel down and traction (**friction**) will be lost. Whatever the design of your vehicle is be sure the weight is over the drive wheels. Traction is the reason most cars have their engine (the heaviest part) over the drive wheels.

Why are most 2WD pick-up trucks rear wheel drive?

LEVERAGE & GEAR RATIOS





HIGH GEAR- A big gear in front and a small gear in back makes it *hard* to pedal and you go *fast*.

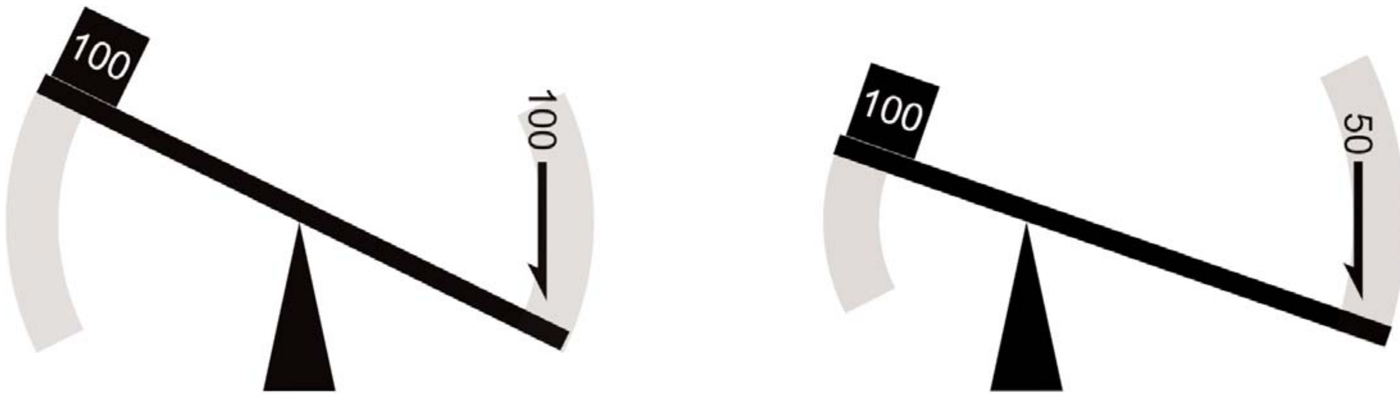
LOW GEAR- A small gear in front and large gear in back makes it *easy* to pedal and you go *slow*.

The easiest way to calculate gear ratios is to count the teeth on the gears. Alternatively you can measure the diameter of the gears. In the high gear example the front gear has 50 teeth and the rear gear has 25. That means every time the front gear is pedaled 1 rotation the back gear and wheel rotate 2 times. Their ratio is 1:2.

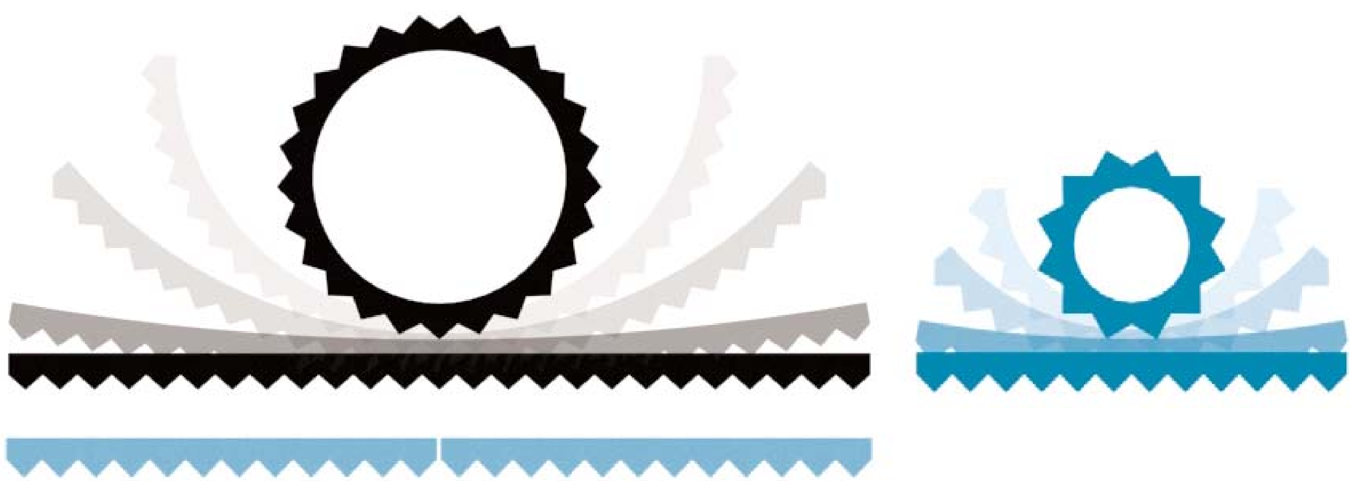
A common low gear ratio for bikes is 1:1. For every rotation of the pedals the rear wheel will rotate once. If your vehicle is heavy you may want to reduce it even more. The vehicle below weighed 500 lbs. with its passenger. It used a front chain ring set and rear cassette from a bike but the ratios were cut in half later in the drive train so that the low gear ratio was around 2:1. The pedals had to make two rotations for the wheels to rotate once. The vehicle was slow but without the low gearing the pilot would not have been able to peddle up hills or thru the mud.

Imagine carrying 50 lbs. up a mountain or 100 lbs. *Which would make you tired sooner? Which could you carry further? Which could you take larger steps while carrying?*

The reason gearing can make it harder or easier to pedal is similar to the way a lever works. A lever allows you to control the distance a force is traveling. If the lever arms between the weight and the force are equal then the force has to travel the same distance down that the weight travels up. In this example 100 lbs. of weight would require 100 lbs. of downward force to lift it and both would travel the same distance.



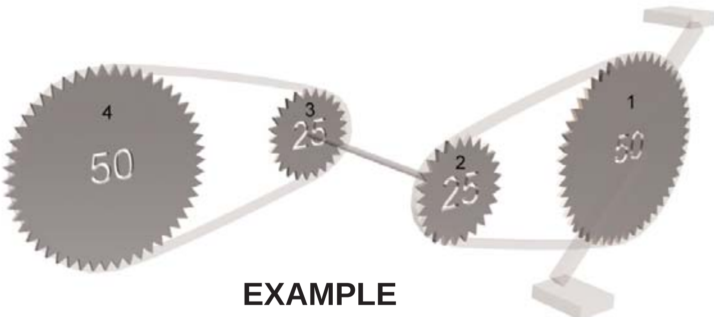
If the lever arm that the force is pushing down is twice as long as the arm with the weight, half the force is required to lift it. In this example 50 lbs. of force could lift 100 lbs. of weight but the force would travel twice the distance of the weight to do so.



A low gear ratio of 2:1 is similar to the 2:1 lever example above. The diameter of a gear with 50 teeth is twice as long as a gear with 25 teeth. The front gear with 25 teeth will have to rotate twice for the back 50 tooth gear to rotate once. Another way to see it is that 25 tooth gear is half the distance of the 50 tooth gear. Because the front gear is half the distance the pedals have to travel twice the distance, 2 rotations, to make the rear wheel travel 1 rotation. By traveling farther they lighten the load. When figuring out gear ratios just think “is the force traveling a shorter or greater distance and is that easier or harder to pedal?”

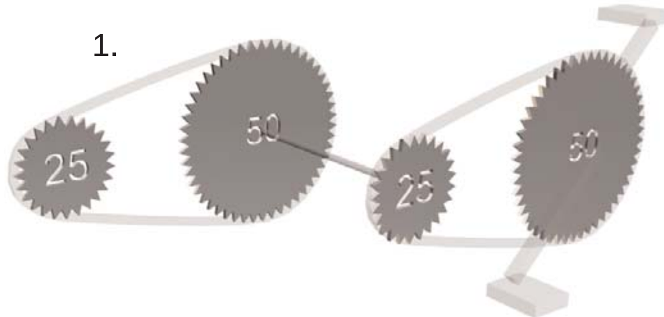
SHOW ME DON'T TELL ME

Calculate the gear ratios of the following set-ups. Write the ratios as input rotations: output rotations. Pedals indicate the input end of the sequence. Remember this is about the relative number of rotations. Two gears on the same shaft will rotate at the same rate regardless of their relative sizes.



EXAMPLE

1.



STEP 1. Identify and simplify the ratio of each gear pair connected by chain.

(gear1) to (gear2) = 50:25 = 2:1

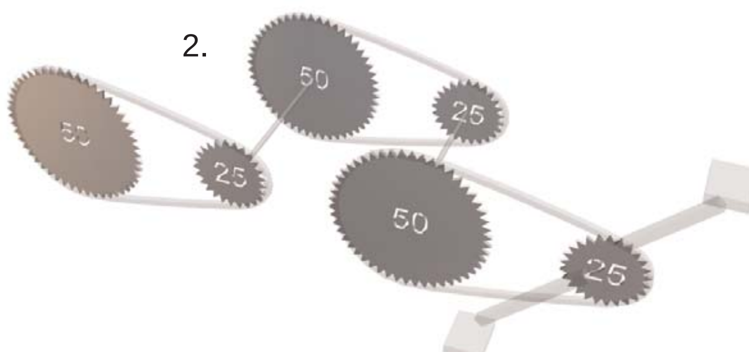
(gear2) & (gear3) are on the same shaft so they rotate at the same speed. The relationship of their size is irrelevant here.

(gear3) to (gear4) = 25:50 = 1:2

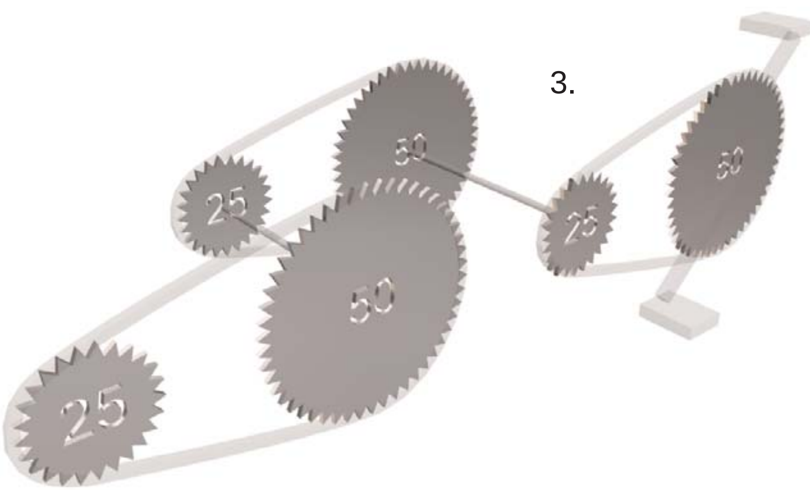
STEP 2. Multiply each side and simplify the ratios

2:1
*<u>1:2</u>
2:2 = 1:1

2.



3.



4. What is the highest gear ratio on the page?

5. What is the lowest?

HARE AND TORTOISE: *A Strange Version*

We all know the tale of the race between the hare and the tortoise. The hare runs faster but the tortoise is slow and consistent. The tortoise wins because "slow and steady wins the race." Many have (or should have) questioned those results. It's time for a rematch. Lets pit the hare and tortoise against each other in a new race, a race to see who can experience the most heart beats before they die. Below are real world, not fairytale, figures.

The hare has a heart rate of 200 BPM (beats per minute) and lives for 10 years.

The tortoise has a heart rate of 25 BPM and lives for 80 years.

WHO WON?
First figure out how many minutes are in a year.
60 min.* 24hrs.* 365days= 525,600 min/year

Next, figure out how many minutes the creature experienced in its life.
525,600*(years of life)

Finally, multiply the number of minutes the creature experienced times the amount its heart beat each minute.
(total minutes)*(BPM)=Total Lifetime Heartbeats

How many heart beats did they each experience and what the heck does this have to do with gear ratios and leverage?(Hint- The answer is not "nothing")