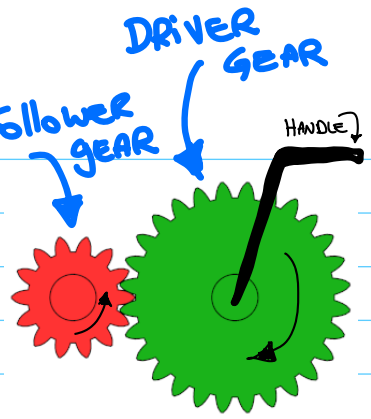
GEARS



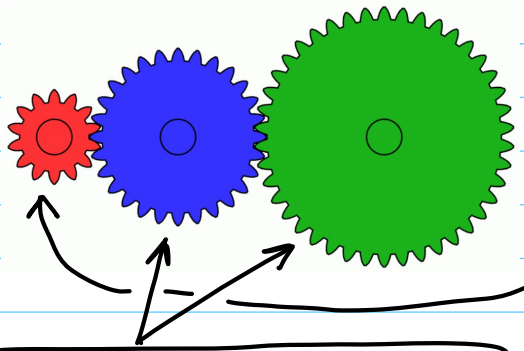
A GEAR HAS 2 (OR MORE) WHEELS THAT HAVE INTERLOCKING TEETH

→ WHEN A GEAR IS ROTATED, IT TRANSFERS MOTION (TORQUE) FROM ONE GEAR TO ANOTHER

→ GEARS W/ INTERLOCKING TEETH WILL ALWAYS ROTATE IN OPPOSITE DIRECTIONS

→ THE LARGER GEAR WHEEL WILL ROTATE SLOWER (GREATER DISTANCE) THAN THE SMALLER BUT ROTATE WITH GREATER FORCE

BUT WHY? → USED TO TRANSFER ENERGY AND TO HELP INCREASE OR DECREASE SPEED IN A MACHINE



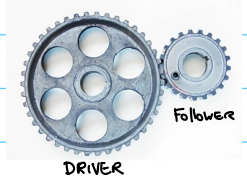
A GEAR TRAIN USES MULTIPLE GEARS → 2 OR MORE

DRIVER GEAR → FIRST GEAR (OR THE GEAR THAT HAS FORCE APPLIED TO IT)

FOLLOWER OR DRIVEN GEAR(S) → THE GEARS THAT FOLLOW OR RECEIVE THE FORCE.

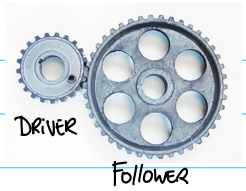
GEAR SPEED → MULTIPLYING VS. REDUCING GEARS

[MULTIPLYING GEAR] WHEN THE DRIVER GEAR IS LARGER THAN THE FOLLOWER GEAR



[ONE ROTATION of DRIVER (LARGER) GEAR = MANY ROTATIONS of follower (smaller) GEAR]

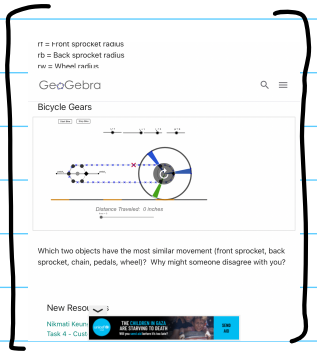
[REDUCING GEAR] WHEN THE DRIVER GEAR IS SMALLER THAN THE FOLLOWER GEAR



[ONE ROTATION of DRIVER (smaller) = SMALLER ROTATIONS of follower (larger) GEAR

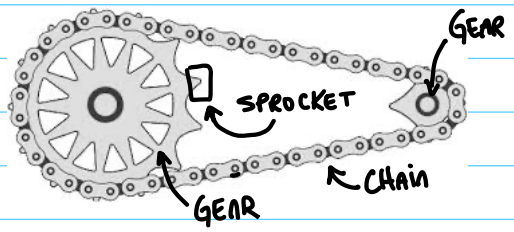
GEAR RATIO

INTERACTIVE GEARS →



https://www.geogebra.org/m/YKJ3ZdJs

- SOME GEARS CANNOT MESH DIRECTLY WITH EACH OTHER → LIKE ON A BIKE
  - → [THINK ABOUT THE DIRECTION THEY ARE TURNING]
  - → TO SOLVE → GEARS JOINED WITH A CHAIN, PROVIDES LINKAGES BETWEEN GEARS of DIFF SIZES.



SPROCKETS → THE TEETH of A GEAR THAT FIT into THE LINKS of A CHAIN.

WHEN LINKED, THE CHAIN MOVED THE SAME DISTANCE in THE SAME PERIOD of TIME

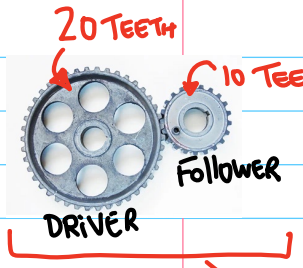
→ [EX: IF front SPROCKETS MOVE THROUGH 45 TEETH THE BACK WILL DO THE SAME (IF GEARS SAME SIZE)]

THE RELATIONSHIP BETWEEN THE SPEED of ROTATION of A SMALLER GEAR & A LARGER GEAR = **GEAR RATIO**

$$\text{GEAR RATIO} = \frac{\text{NUMBER of FOLLOWER GEAR TEETH}}{\text{NUMBER of DRIVER GEAR TEETH}} \qquad \frac{\text{Follower}}{\text{DRIVER}}$$

A RATIO > 1 = DRIVER TURNS FASTER THAN FOLLOWER ⇒ ↓ TORQUE ↑ SPEED

< 1 = DRIVER TURNS SLOWER THAN FOLLOWER ⇒ ↑ TORQUE ↓ SPEED



DRIVER ROTATES 1x

FOLLOWER ROTATES 2x

OUTPUT SPEED = 2x INPUT SPEED.

$\frac{\text{FOLLOWER SIZE}}{\text{DRIVER SIZE}} = \text{GEAR RATIO}$

$\frac{10}{20} = \frac{1}{2} =$ 1:2 RATIO

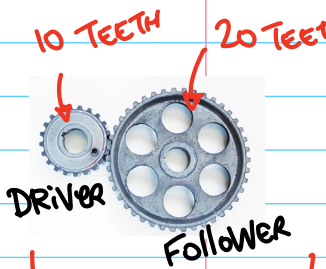
0.5

REAL LIFE → CRUISING ON FLAT GROUND ON BIKE

→ 1 PEDAL = MORE SPEED

↓ TORQUE (PEDAL LENGTH VS. SIZE of input GEAR) → LOW LEVERAGE WHICH IS WHY IT IS HARDER TO PEDAL THIS GEAR

↑ OUTPUT SPEED → BACK GEAR ROTATES MORE THAN input



DRIVER ROTATES 1x

FOLLOWER ROTATES 0.5x

OUTPUT SPEED = $\frac{1}{2}$ INPUT SPEED.

$\frac{\text{FOLLOWER SIZE}}{\text{DRIVER SIZE}} = \text{GEAR RATIO}$

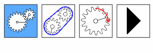
$\frac{20}{10} = \frac{2}{1} =$ 2:1 RATIO

2

REAL LIFE → GOING UP A HILL ON A BIKE

↑ TORQUE (PEDAL LENGTH VS SIZE of INPUT GEAR) → HIGH LEVERAGE WHICH IS WHY IT IS EASIER TO PEDAL

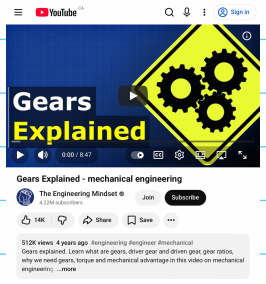
↓ OUTPUT SPEED → BACK GEAR DOESN'T ROTATE AS MUCH



https://frankleenaars.github.io/gearsketch/

GEAR SKETCH

INTERACTIVE GEAR MODELLER



WATCH: GEARS EXPLAINED

https://youtu.be/4ROtKKuSaBI

CONSIDER THIS ?

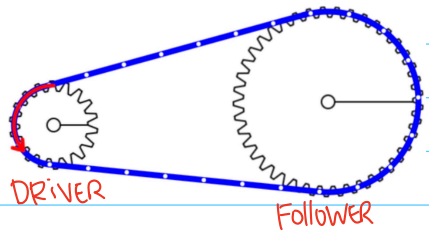
FORCE vs TORQUE

- CAUSES LINEAR MOTION (PUSH/PULL)
- MAKES things go straight

- ROTATIONAL VERSION of FORCE
- MAKES things turn AROUND A POINT

- [FORCE × RADIUS = TORQUE]

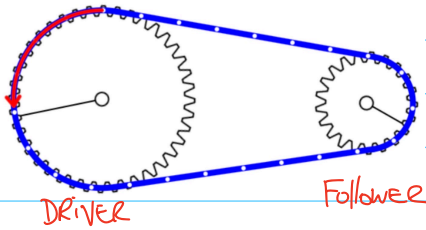
So...



[SMALL DRIVER / BIG FOLLOWER]

- EASY GEAR
- MORE TORQUE
- LESS FORCE REQUIRED to turn DRIVER GEAR
- ONE PEDAL MAKES BACK WHEEL TURN LITTLE

[LESS Efficient, EASY to PEDAL]



[BIG DRIVER / SMALL FOLLOWER]

- HARD GEAR
- LESS TORQUE
- MORE FORCE REQUIRED to turn DRIVER GEAR
- ONE PEDAL MAKES BACK WHEEL TURN LOTS

[MORE Efficient, HARDER to PEDAL]