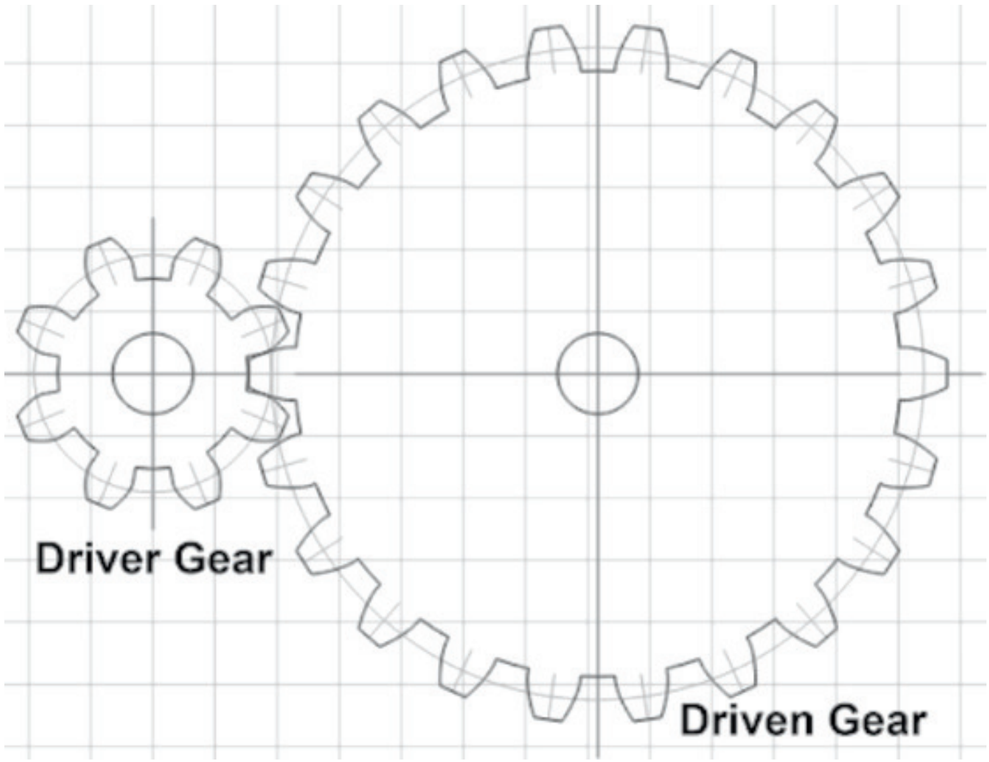
Gears

Gears

Gears are mechanical devices with teeth that fit together to **transfer motion** between turning rods called shafts. When one gear spins, it helps the gear next to it turn, and it also passes that motion along to other parts of a machine. This allows machines to change the speed, direction, or strength of movement.

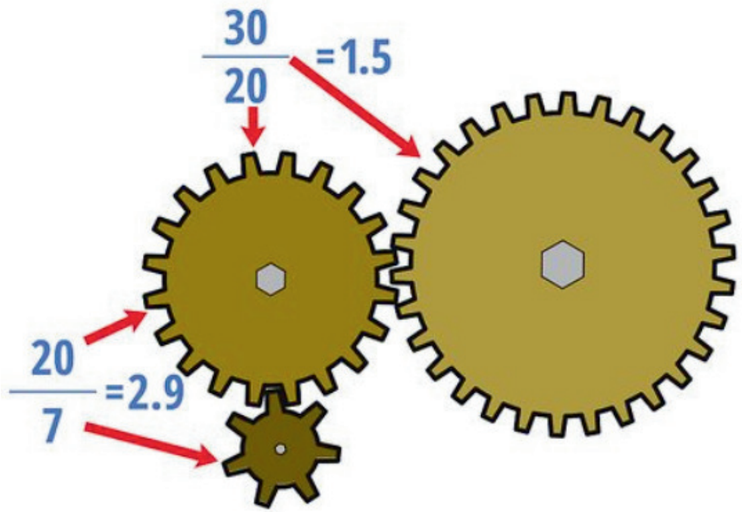
Can you think of some places where gears might be used in everyday life?



In a gear system, the gear connected to the power source is known as the **driver gear**, while the gear that delivers the output is called the **driven gear**.

Gear Ratio

Gear Ratios are used to describe the relationship between the sizes or speeds of two meshing gears. It determines how motion, torque, and speed are transmitted through a gear system.



$$\text{Gear Ratio (GR)} = \frac{T_o}{T_i} = \frac{D_o}{D_i}$$

T_o: Number of teeth on the output gear

T_i: Number of teeth on the input gear

D_o: Diameter of the output gear

D_i: Diameter of the input gear

Gear Ratio Formats

Gear Ratio Format	How it Works	Effect on Speed	Effect on Torque
2:1 2 2/1	Driven gear rotates once for every 2 driver rotations.	Speed decreases	Torque increases
1:2 0.5 1/2	Driven gear rotates twice for every 1 driver rotation.	Speed increases	Torque decreases
1:1 1.0 1/1	Driver and driven gears rotate at the same speed.These gears are called idler gears and change the direction of rotation	No change	No change

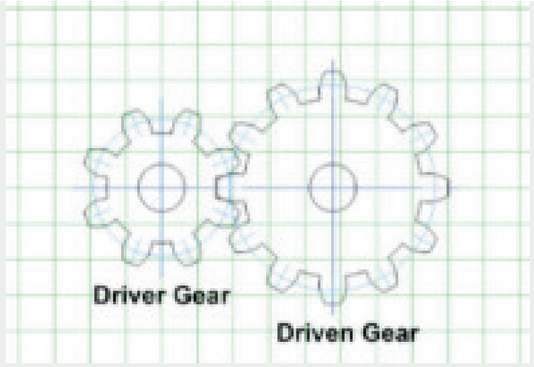
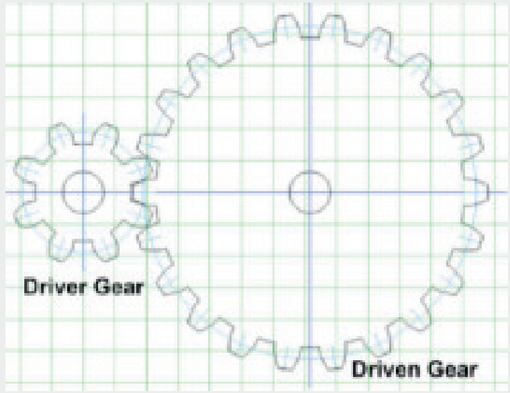
Torque and Speed

The tradeoff between torque and speed is achieved by stepping up or down in gear size.

Torque is the twisting force that makes things turn.

A high-torque, low-speed setup will accelerate quickly but may not achieve high top speeds.

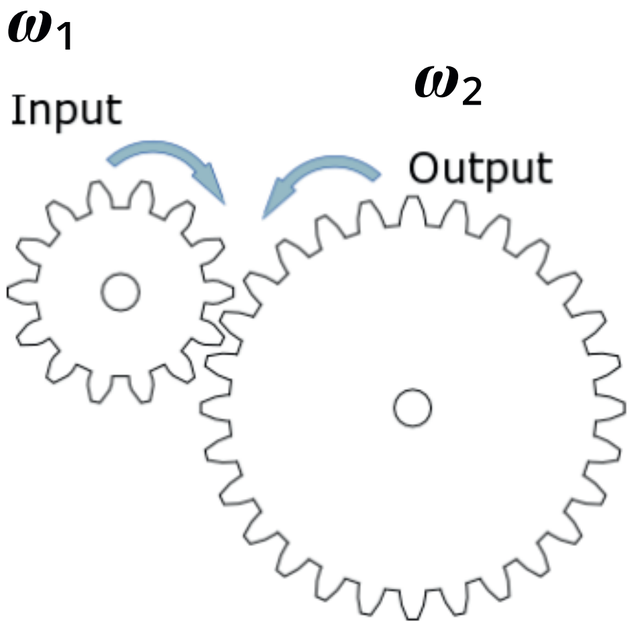
A low-torque, high-speed setup may take longer to accelerate but reaches higher speeds eventually.

Small Gear Ratio	
	Faster overall speed Lower torque
Large Gear Ratio	
	Lower overall speed Higher torque

Rotational Speed

Rotational speed measures how fast an object spins around its axis or a fixed point, usually expressed in RPM (revolutions per minute) or radians per second (rad/s).

Gears can adjust rotational speed based on their gear ratio: a larger gear (with more teeth) reduces speed when paired with a smaller gear, while a smaller gear increases speed when driving a larger gear.

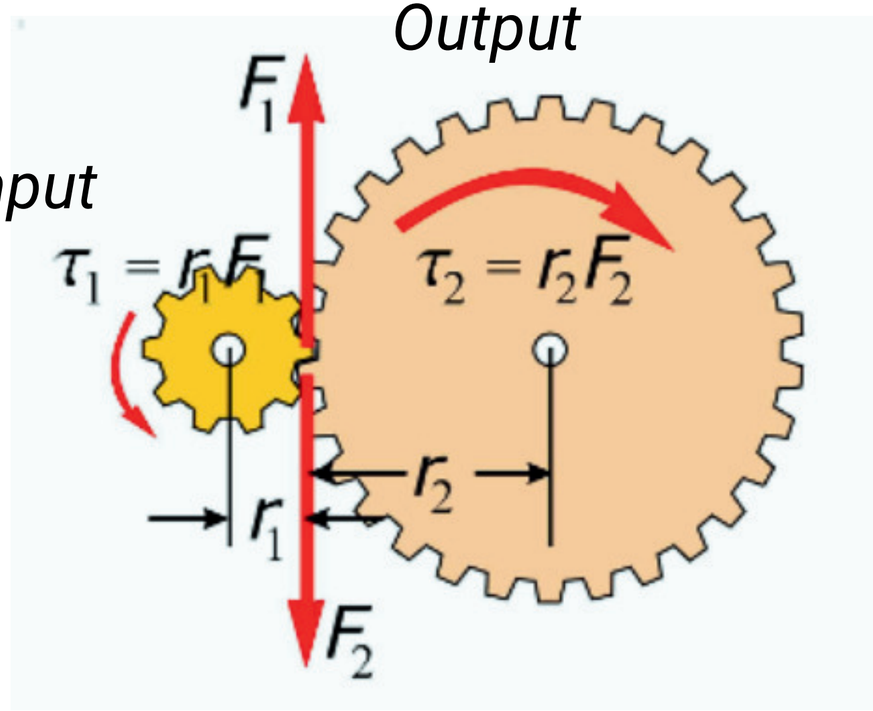


Because the diameter of the driver or input gear is smaller than the diameter of the driven or output gear, the **angular speed of the driver gear ω_1 is greater than the angular velocity or driven gear ω_2**

Torque

Torque is the rotational force exchanged between gears, representing the tendency of a force to cause rotation around an axis. It is calculated as the **product of the applied force (F) and the distance (r)** from the axis of rotation.

In gear systems, torque determines the capacity to produce rotational motion or overcome resistance. It is measured in units such as foot-pounds (ft*lbs) or newton-meters (N*m).

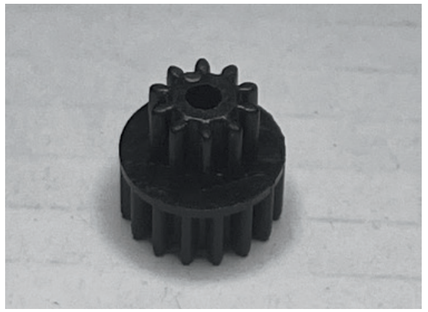


Torque of the input or driver gear τ_1 is less than the torque of the output or driven gear τ_2 because the input gear has a smaller diameter.

H2 Grand Prix Sprint Car Gears

Before we assemble your Sprint Car, let's learn about the gears it uses and how to choose and adjust them. Start by closely examining the gears.

There are two, two sided driver gears.

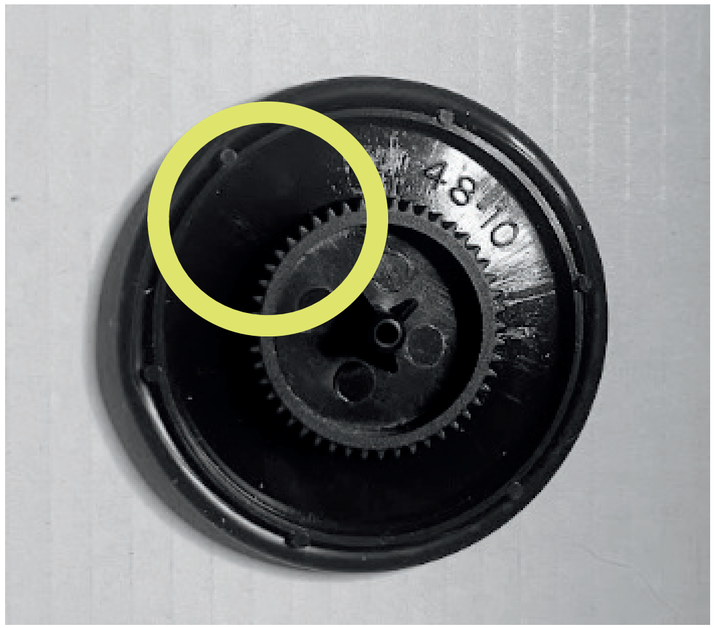


There are four driven gears which are embedded in the wheels of the car.

Notice the numbers engraved into the wheels of the car. What do you think these numbers mean?

H2 Grand Prix Sprint Car Gear Ratios

The engraved numbers represent the gear ratio for each wheel when paired with a specific driver gear. For example, a 10-tooth driver and a 48-tooth driven gear give a ratio of 48:10.



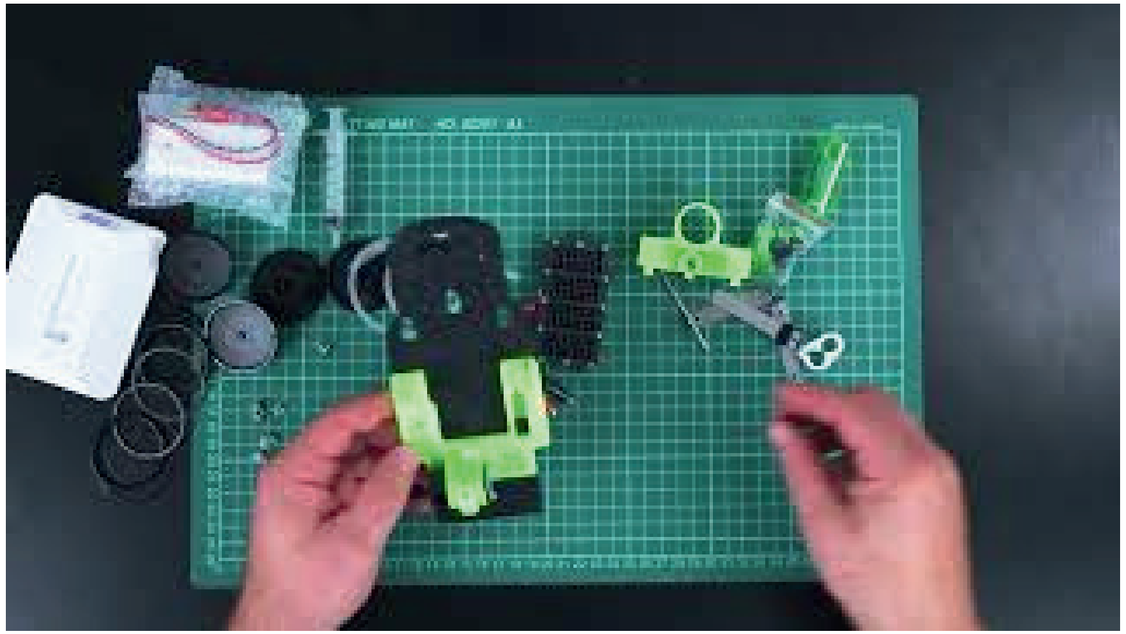
The first number inside each wheel indicates the gear's teeth count, while the second suggests a possible driver gear tooth count.

You are not restricted to these specific ratios—you are free to experiment with any combination of wheels and driver gears to achieve your desired configuration.

Based on what you know about torque and speed, **decide with your team which gear ratio to start with**. This can be changed later after the first speed trials.

Ready to Assemble?

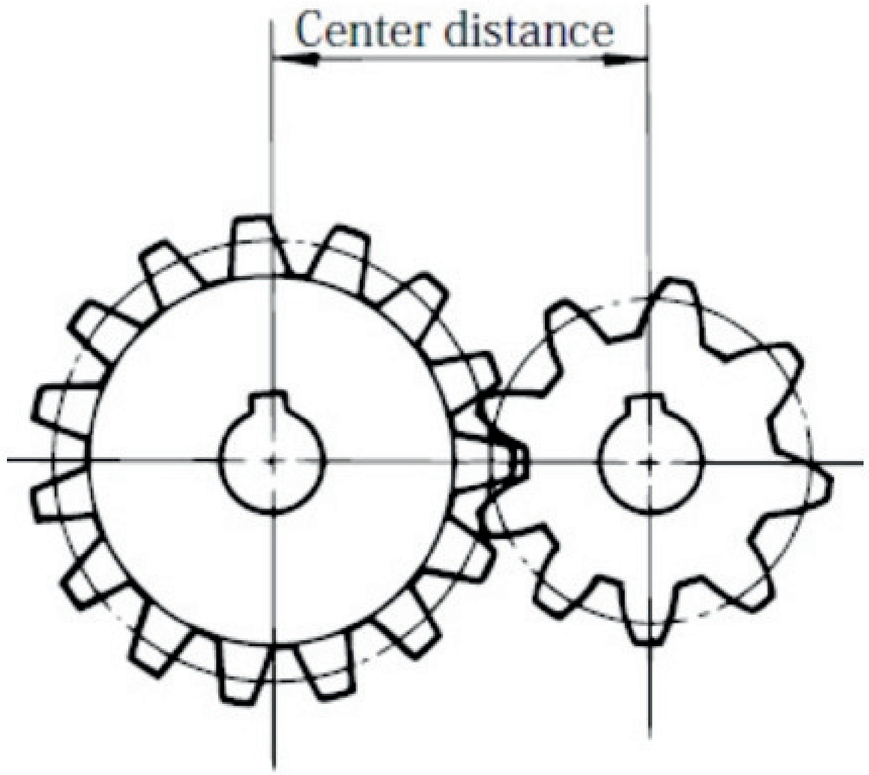
Now that you have decided on your gear ratio, let’s get started assembling your H2 Grand Prix Sprint!



Gear Center Distance

The center distance in gears is the physical distance between the centers of two meshing gears.

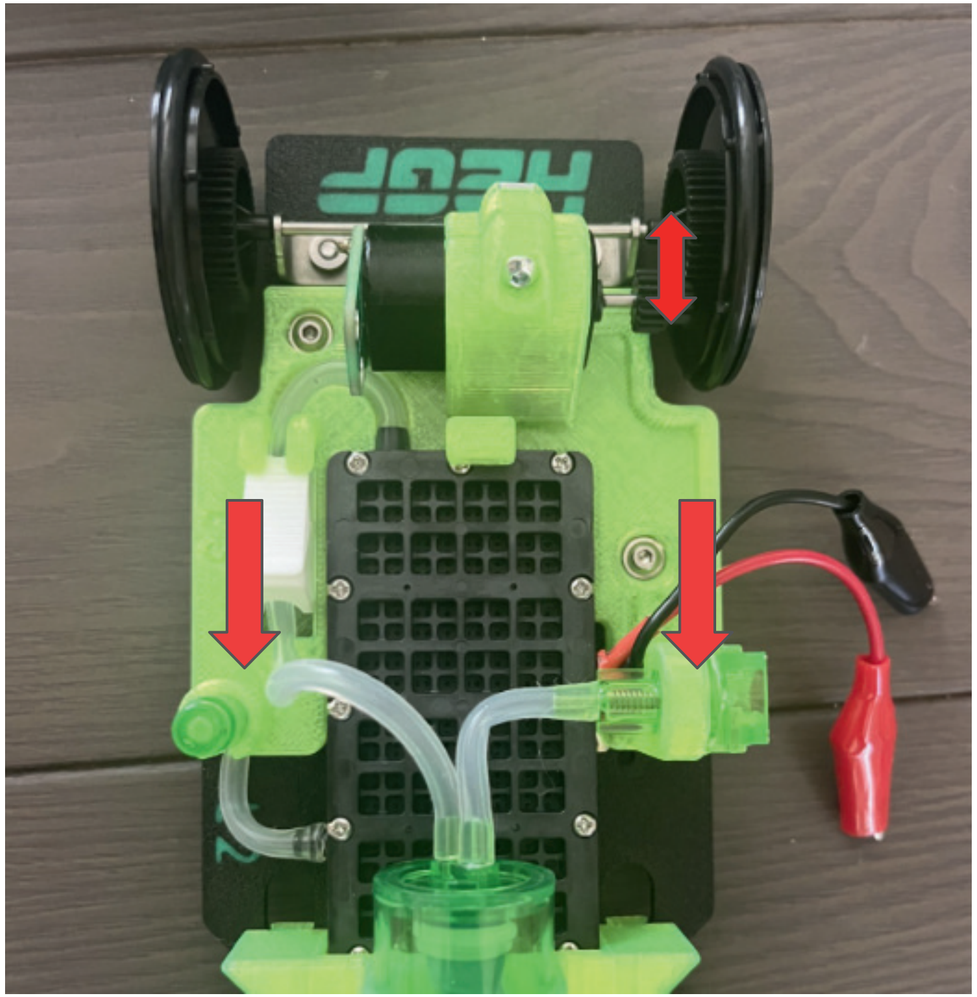
It is critical for ensuring proper alignment and smooth engagement of the gear teeth. Accurate center distance allows gears to transmit motion and power efficiently, minimizing wear and preventing noise or mechanical failure.



Alignment of the Center Distance

The Sprint Car allows adjustment of the motor assembly to position it farther from the front axle, which **sets the center distance.** To do this, simply loosen the screws, slide the U-shaped bracket to the desired position, and then retighten the screws.

The center distance should be set so that the the gears mate without any tension in the motor shaft. When you turn the wheel the motor assembly should turn easily. See assembly guide for more details.

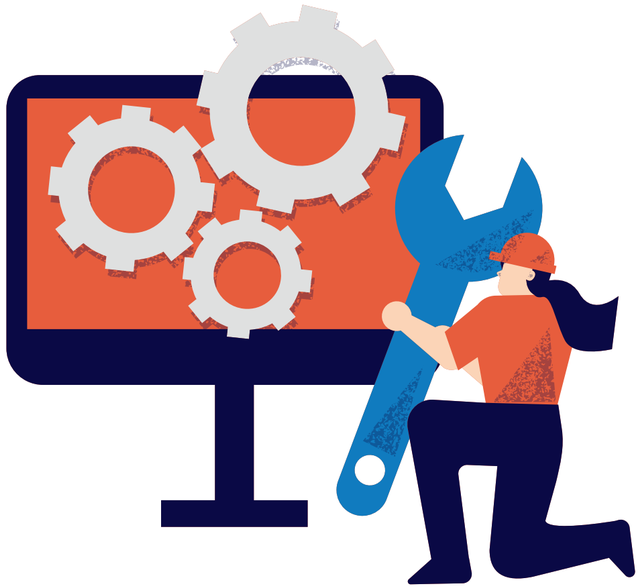


Initial Testing and Troubleshooting

Before heading to the track, test your car at your build station.

Hold it up so the wheels can spin freely, and make sure the motor and gears are working properly.

Fix any issues now—don’t wait until you’re on the track!



Troubleshooting Tips

If the balloon isn’t filling with hydrogen:	If the motor isn’t working:
• Check for any kinks or pinches in the tubing that could obstruct gas flow. • Ensure tubing is securely attached and fully covers the nozzles to prevent leaks. • Verify that the male and female valves are properly connected and tightly closed with a twist to allow hydrogen to flow. • Make sure the AA batteries are fully charged and functioning properly.	• Ensure the clips are securely connected to the motor terminals. • Ensure the balloon contains enough hydrogen to supply the fuel cell. • Inspect wires and connections for any damage or loose components. • Test the motor separately to confirm it is functioning properly. • Ensure center distance is aligned so that tension is not preventing the motor from turning.

Ready to Test Your H2 Grand Prix Sprint Car!

Now that you have finished assembly, let's test your H2 Grand Prix Sprint car!