

The background is a solid blue color with a repeating pattern of white mechanical icons. These icons include gears of various sizes, wrenches, pliers, screws, bolts, and other tools. The pattern is dense and covers the entire background.

Lesson 6: Wheels

By the end of this lesson, you will be able to:

- Define what wheels are and give examples of how they're used.
- Explain the differences between various wheel types.
- List the advantages and disadvantages of each type of wheel.
- Apply what you've learned about wheels to robots and the engineering design process.



Introduction

In the last lesson, you learned about electronics and electronic systems, and you added electronics to your beginner Robits chassis. In this lesson, you'll learn about different types of wheels that are used on robots, as well as the advantages and disadvantages of each type of wheel. Toward the end of the lesson, you'll experiment with how different types of wheels affect the performance of your robots, and you'll even get to race your robots!



What are wheels?

What are wheels?

As you learned in Lesson 2, a wheel is a circular piece of material that can be solid, partially solid, compliant, or spoked and is capable of turning on an axle. Wheels are the parts of a vehicle that come into contact with the ground, and so because of this and their ability to spin, they're able to drive vehicles forward. Wheels can be highly specialized to fit a given environment. For example, an F1 car uses smooth wheels designed for speed, while a tractor uses rough wheels built to gain traction. A wheel's ability to reduce friction or gain traction determines what jobs the wheel is best suited for.



The background is a solid blue color with a repeating pattern of white mechanical icons. These icons include gears, wrenches, pliers, screwdrivers, hammers, and other tools, as well as symbols like stars and Wi-Fi signals.

Discussion:

With your group, discuss where you've seen wheels used in your daily life.



**Where are wheels used in
daily life?**

Examples of Wheels in Use:



Cars, trucks, and vans are probably the most common places we see wheels in our daily lives, since billions of people use these vehicles to get to school or work every day.



Bicycles typically have very skinny wheels that are made for cruising along open land, however, a bike's wheels can be easily swapped out for different wheels so that it can adapt to different terrains.



Bus wheels play an important role in keeping students safe. They must be strong enough to support the weight of all the students in the bus and they must retain their traction in any weather condition.

Examples of Wheels in Use:



Tractors have massive wheels with deep treads. Wheels like these allow tractors to gain an immense amount of traction so they can pull huge loads and drive over nearly any terrain.



Wheelchairs, as the name would suggest, are another common place where wheels are used. Wheelchairs are an incredible tool, as they provide their users with a way to stay mobile.



Office chairs or gaming chairs have wheels that are much smaller than any of the wheels in the previous examples, however, having so many small wheels allows these chairs to move and rotate with ease.

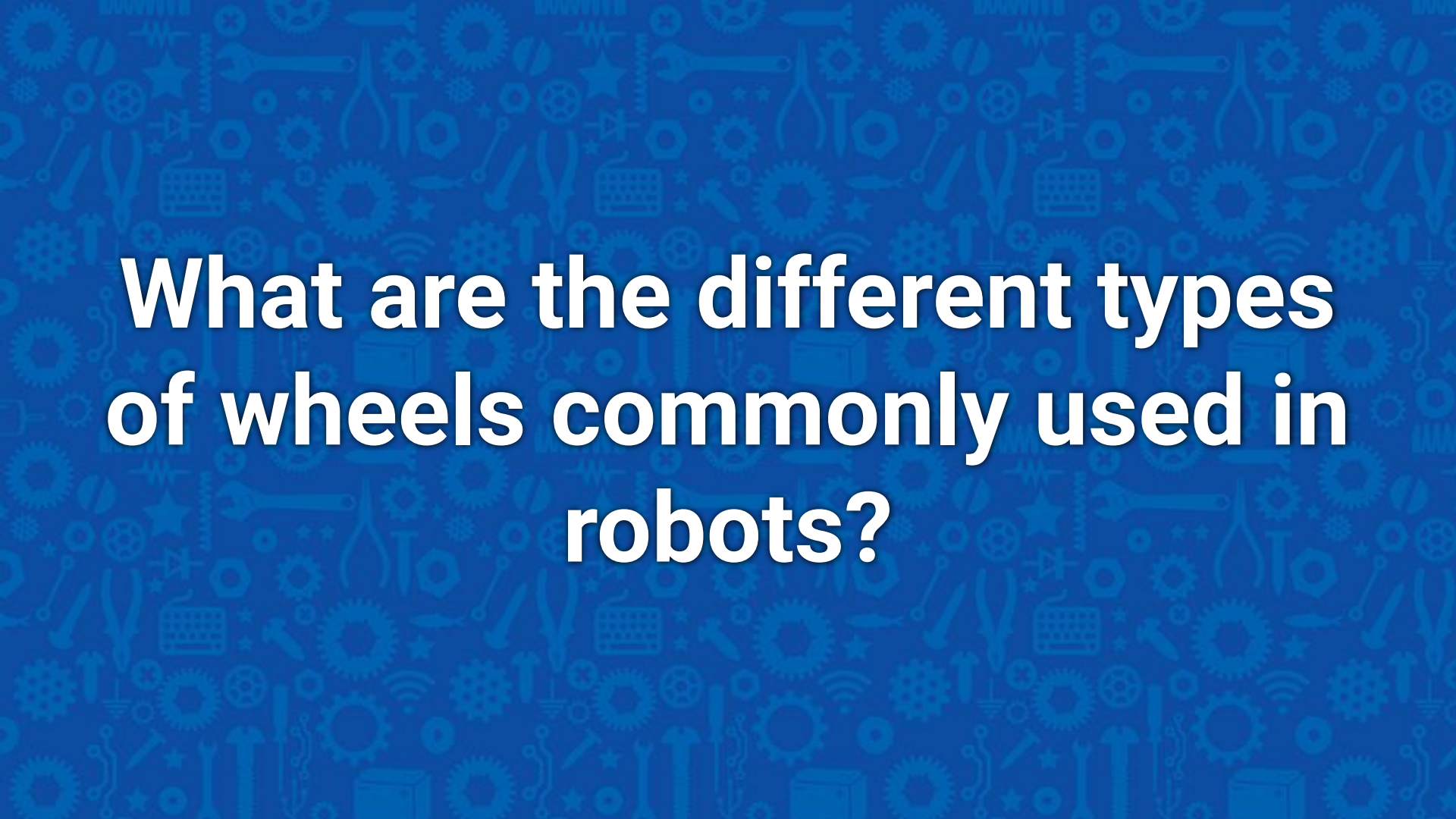


**How do wheels apply to
robots?**

Wheels on a Robot

As you learned in Lesson 4, a large portion of robots use wheeled chassis, and so they use wheels as their primary form of propulsion. That being said, robots use wheels for more than just propulsion. They also use wheels to manipulate objects in the environment around them. For example, some robots use wheels as part of their intake system, a system designed to draw objects into the robot. No matter how a robot uses a wheel, it is important for it to use the right type of wheel for the job, and as it happens, there are many different types of wheels that robots can use.





**What are the different types
of wheels commonly used in
robots?**

Types of Wheels:

Robots and vehicles use a variety of different types of wheels because each type of wheel is specialized for a specific purpose. In general, most robots use one or more of the following five types of wheels:

- Stealth Wheels
- Traction Wheels
- Omni Wheels
- Mecanum Wheels
- Compliant Wheels

In the following slides, we will discuss the differences between each type of wheel. We will also look at some of the advantages and disadvantages of each type. Pay close attention to this, as it will be useful in later parts of the lesson.

The background is a solid blue color with a repeating pattern of white mechanical icons. These icons include gears of various sizes, wrenches, pliers, screwdrivers, and other tools, creating a technical or engineering theme.

**What are the differences
between each type of wheel?**

Stealth Wheels

Stealth wheels are a fairly basic type of wheel. They typically consist of a hard core with a smooth rubber exterior. They are made for driving on smooth, even surfaces, and they're well suited for driving at high speeds. The wheels on an F1 car, for example, could be considered stealth wheels.



Traction Wheels

Traction wheels are another fairly basic type of wheel. They too have a hard core with a rubber exterior, but unlike stealth wheels, the rubber is rough and textured. Traction wheels work best on uneven, rugged surfaces, such as carpet, dirt, or gravel. A tractor is a great example of a vehicle that uses traction wheels.



Omni Wheels

Omni wheels are a more complicated type of wheel. They are generally made of several small rubber wheels held together at the edge of a hard frame. These small wheels are able to rotate freely, and so omni wheels offer a greater degree of motion than stealth or traction wheels. Additionally, being able to roll in any direction greatly reduces the amount of friction experienced, but as a result, omni wheels also have less traction.



Mecanum Wheels

Mecanum wheels are similar to omni wheels in that they have a hard frame with smaller wheels on the edges. Unlike omni wheels, the smaller wheels are at an angle. This quality allows mecanum wheels to turn with less friction than stealth or traction wheels, but more friction than omni wheels. Mecanum wheels enable a robot to move in any direction without turning and they work best on partially smooth surfaces.



Compliant Wheels

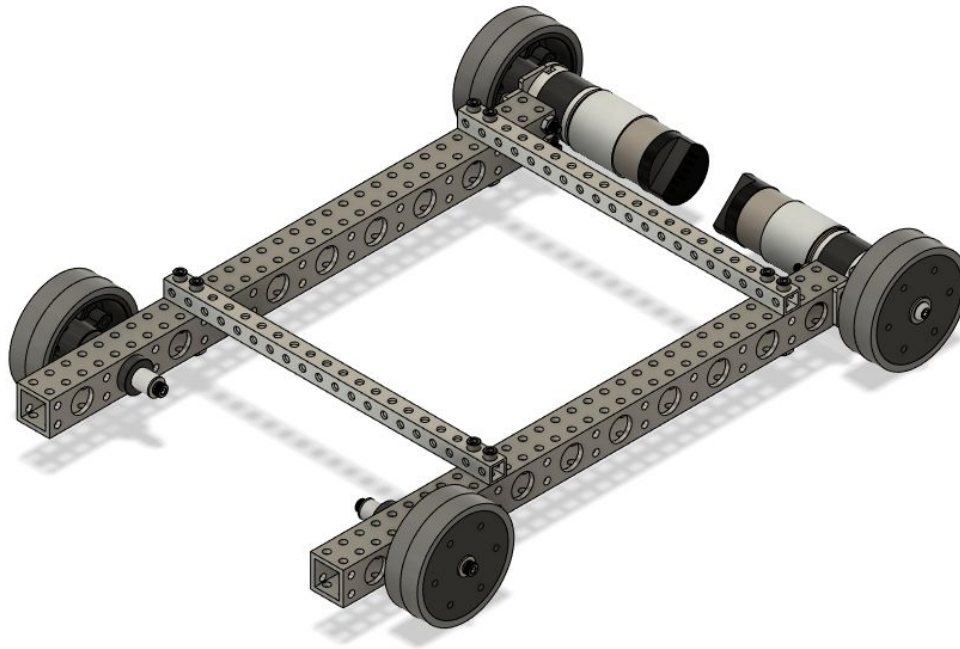
Compliant wheels can have the most variety of any type of wheel. They are all made of rubber, but only larger compliant wheels have a small plastic core. Compliant wheels can come in a range of sizes, and their rubber can vary in firmness, denoted by color. They have more grip strength than any other type of wheel, but they lack structural integrity. Compliant wheels aren't used for driving, instead, they are used for gripping and manipulating objects.



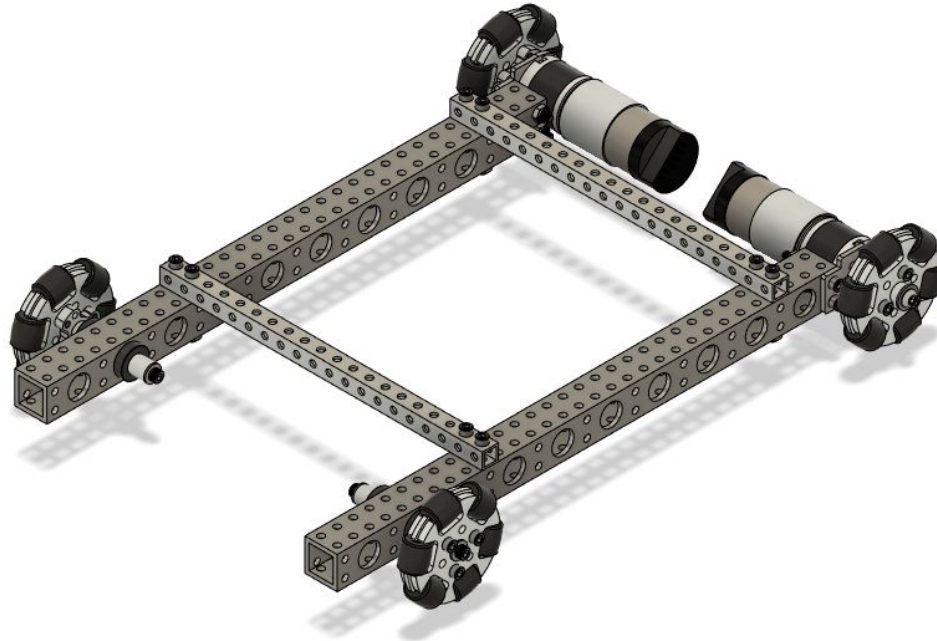
Activity:

Let's test how your robot functions using different types of wheels. To complete this activity, you'll need more wheels than are included in your kit, so either ask your teacher if they have extra wheels, or partner with another group.

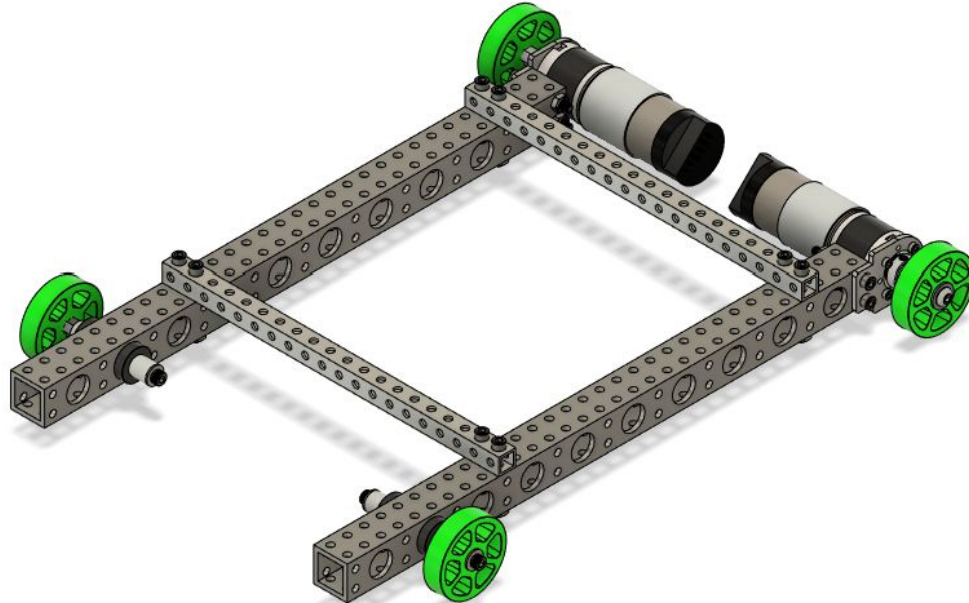
First, let's test how your robot functions using only stealth wheels. Replace all four wheels on your robot with stealth wheels and try driving it around. What do you notice?



Now let's test how your robot functions using only omni wheels. Replace all four wheels on your robot with omni wheels and try driving it again. What do you notice this time?



Optional: If you'd like to test how your robot functions using only compliant wheels, replace all four wheels on your robot with compliant wheels, then try driving it around. What do you notice in this case?





**What did we learn from this
activity?**

What did we learn?

- Traction wheels work well driving straight but they have difficulty turning.
- Omni wheels are very effective at turning but they tend to slip while driving straight.
- Compliant wheels have trouble supporting the weight of the robot and can barely turn.



**Now let's apply what we
learned.**

Activity:

Let's race our robots! Using what you now know about wheel types, choose which types of wheels you want to use on your robot and how many of each type of wheel you want to use, then attach them to your robot so that their placement will give you the desired functionality.

Once you've attached your desired wheels, have your teacher help you find a good spot to act as your race course. You can either use a long stretch of space such as a hallway, or you can design a loop in your classroom. Use whichever option you prefer or let your teacher decide which option to use based on what's available.

Once you've decided on a race course, choose where you'll have your starting line and where you'll have your finish line. Line up your robots behind the starting line, then have your teacher count you off. The group whose robot crosses the finish line first wins the race!



**What did we learn from this
activity?**



**How did your choice of
wheels impact your robot's
performance?**



**Look at the winning team's
robot. What do you notice
about it?**

Discussion:

With your group, think about what you would do if you were to race again. How could you improve your robot?



**How could we improve our
robots?**

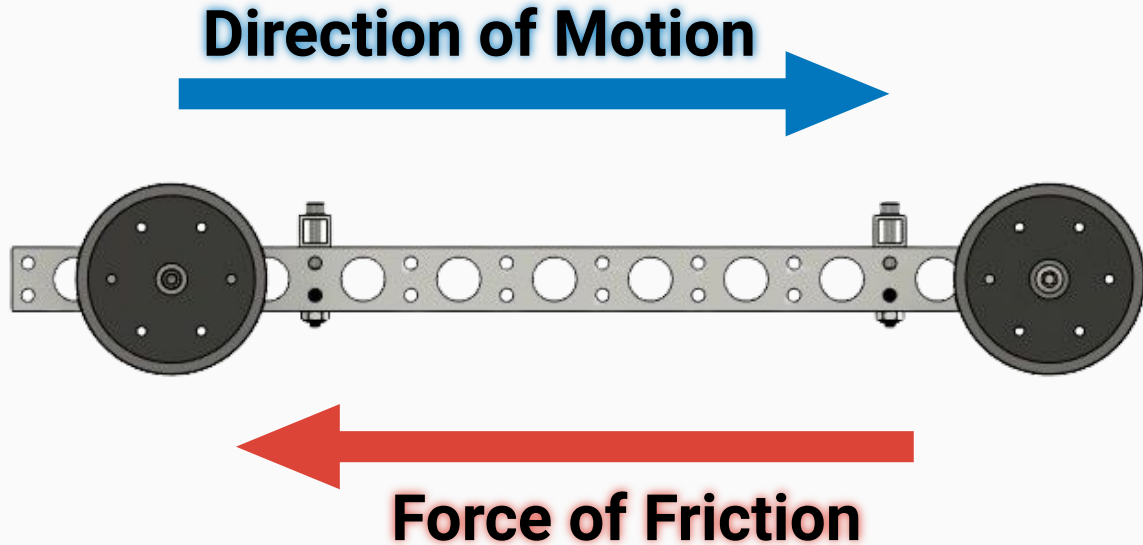
Larger Wheels

One way to make your robot go faster is to give your robot larger wheels. The way this works is larger wheels and smaller wheels both take the same amount of time to rotate, but because larger wheels have a greater circumference, they're able to cover more ground in that time. Because of this, larger wheels can make your robot drive faster than smaller wheels.



Decrease Friction

Friction is a force that acts in the opposite direction of an object's motion. For example, if you were to push a box across the ground, you'd feel resistance. That resistance is friction. Robots experience friction, too. If your robot only used stealth wheels, it would've experienced more friction than a robot that used only omni wheels or a combination of omni wheels and stealth wheels. To decrease friction, you could either use more omni wheels, or remove unnecessary wheels.



Gears

As we touched upon in Lesson 2, gears can be used to build transmissions that modify the speed and torque (turning power) of a system. In this case, we're more interested in gears being able to make things faster. To make your robot faster, you'll have to run gears from your motors to your wheels in such a way that they increase the number of times your wheels spin per motor rotation.



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