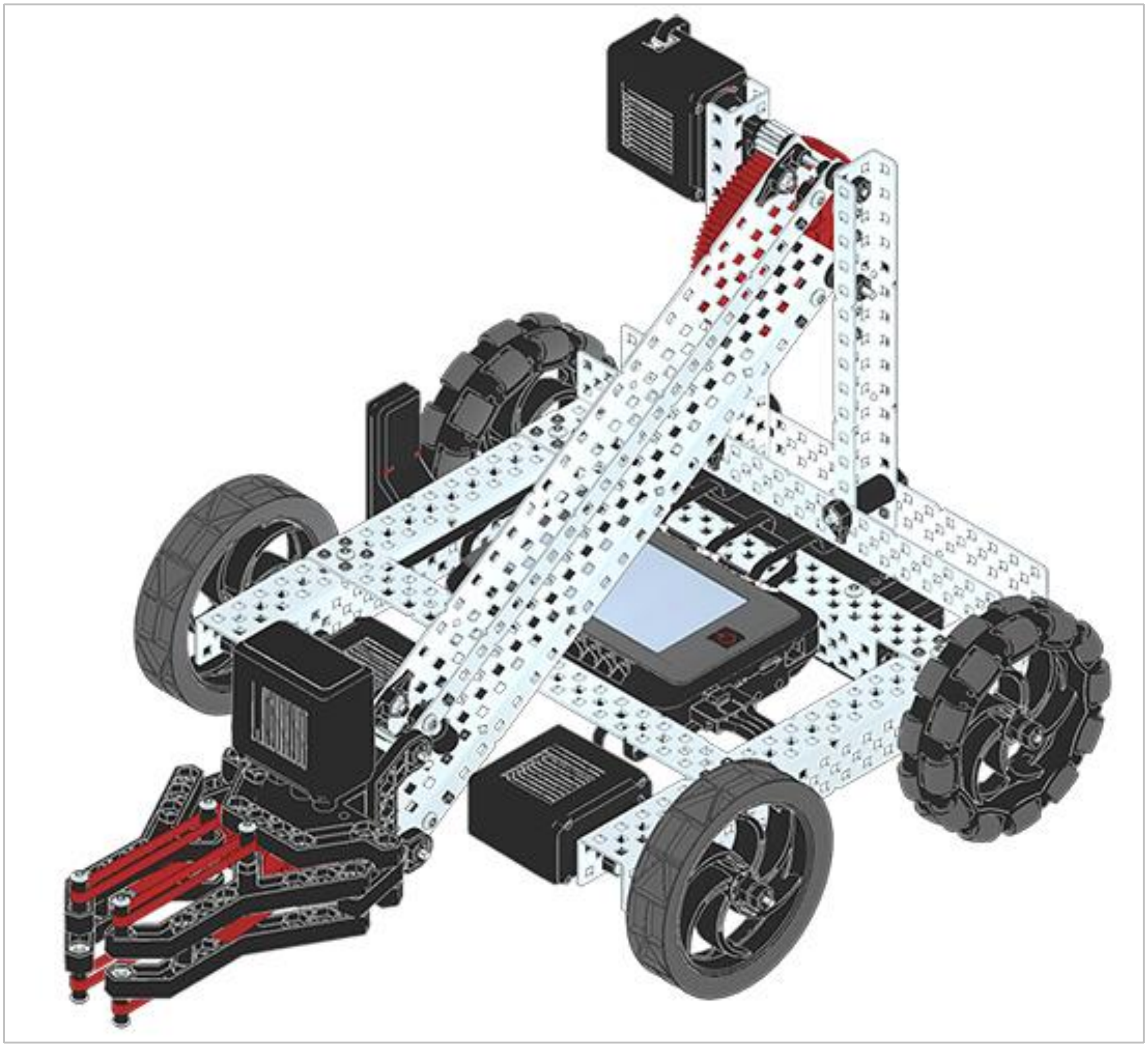
Clawbot with Controller

Program the VEX Controller to direct the Clawbot through several engaging challenges using the concept of loops.

Discover new hands-on builds and programming opportunities to further your understanding of a subject matter.

The Completed Look of the Build



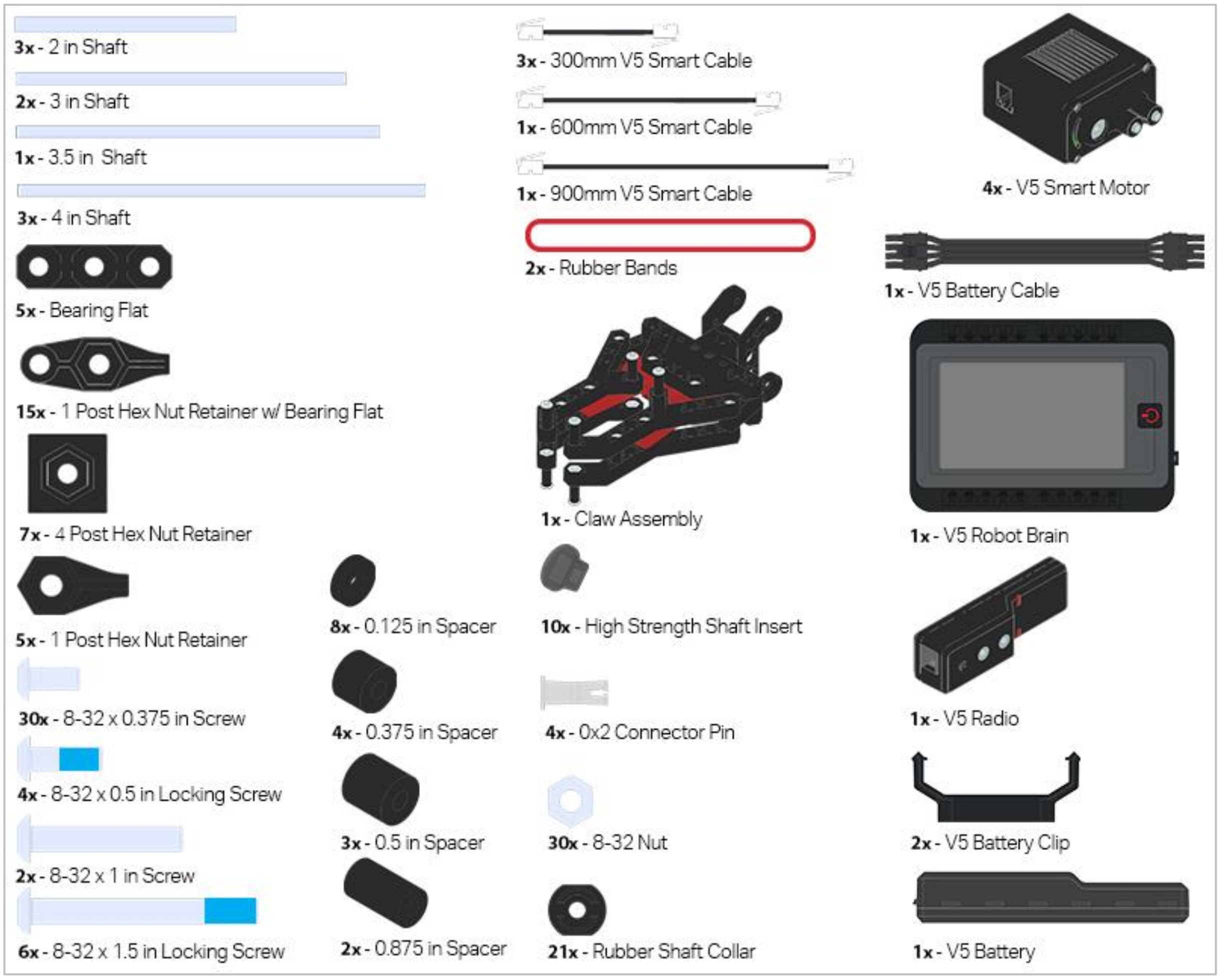
Completed VEX EDR V5 Clawbot

The VEX EDR V5 Clawbot is an extension of the VEX EDR Speedbot that can be programmed to move around and interact with objects.

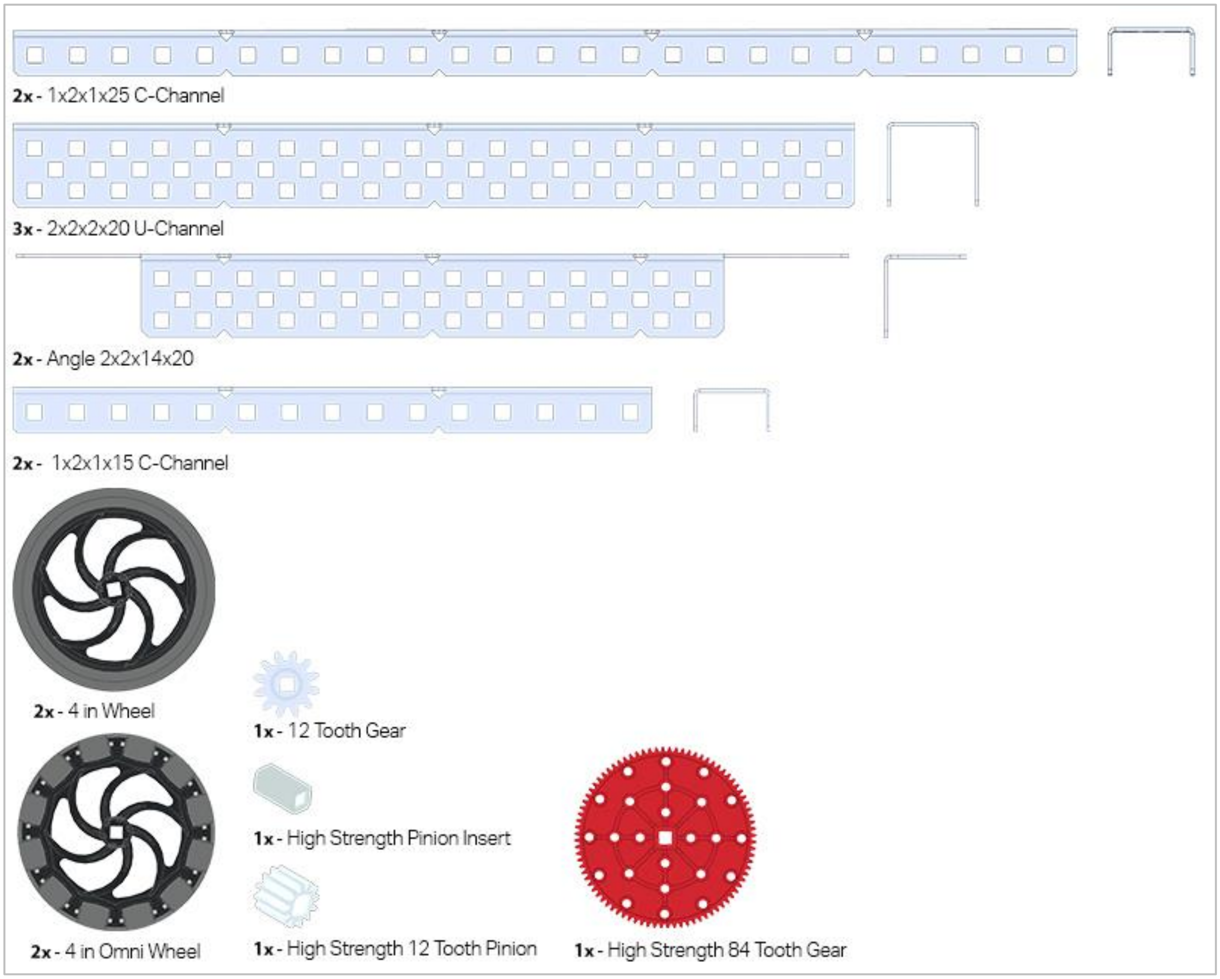
Parts Needed: Part 1

Can be built with:

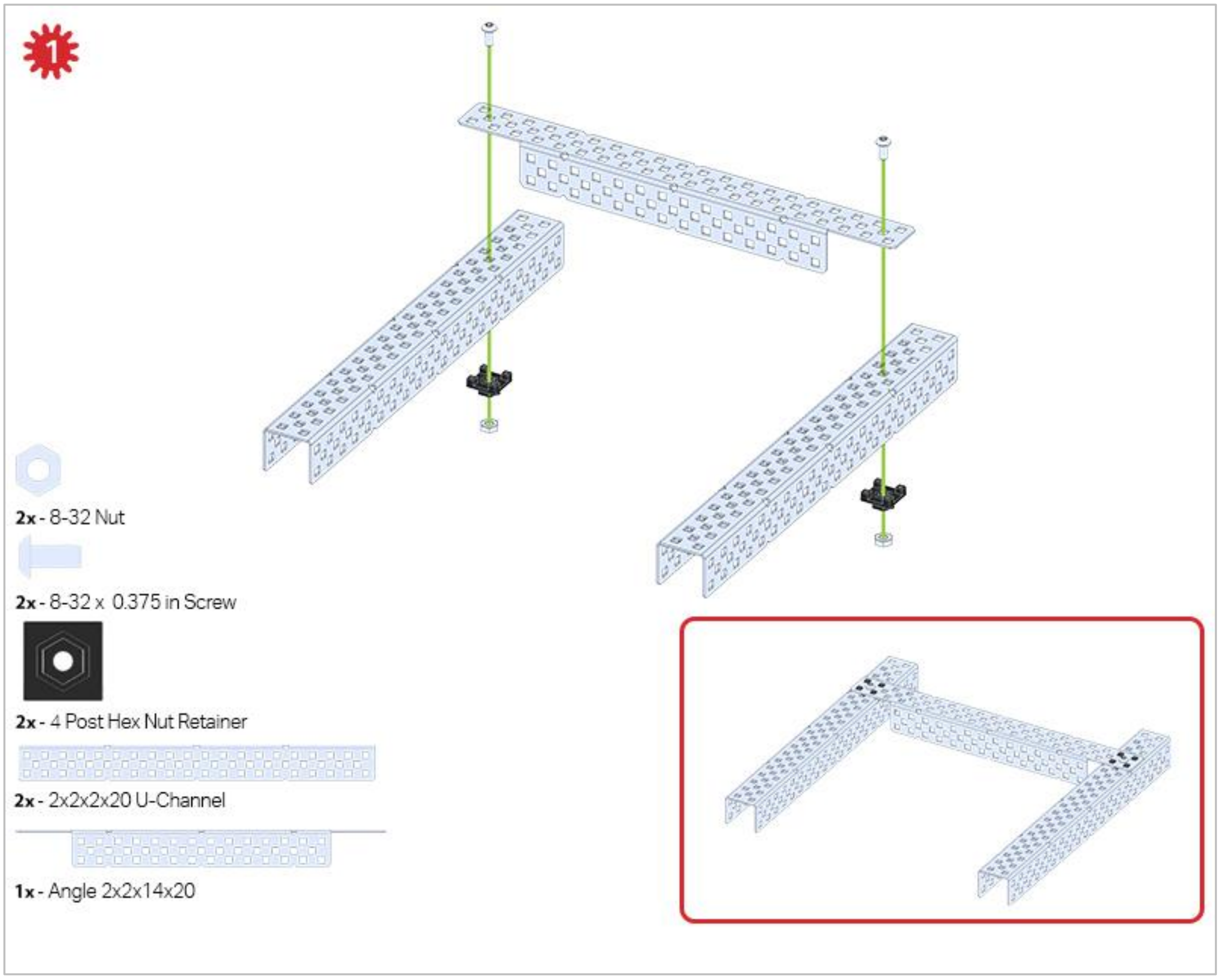
- VEX EDR V5 Classroom Starter Kit



Parts Needed: Part 2



Build Instructions



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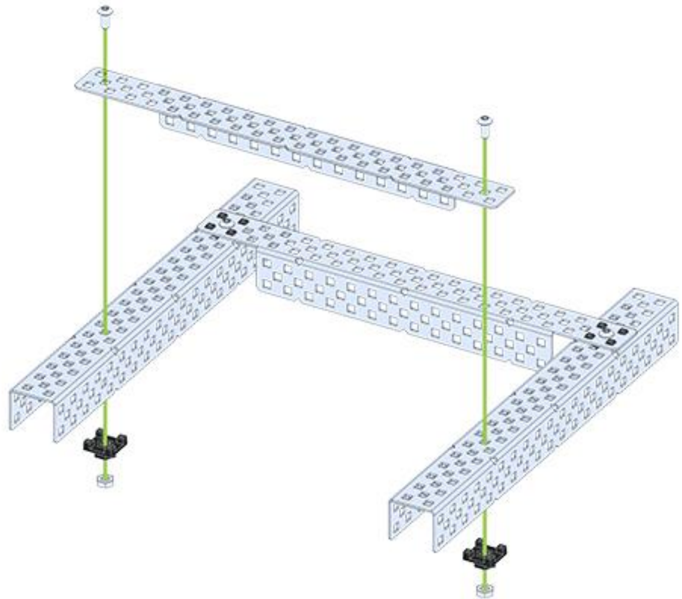
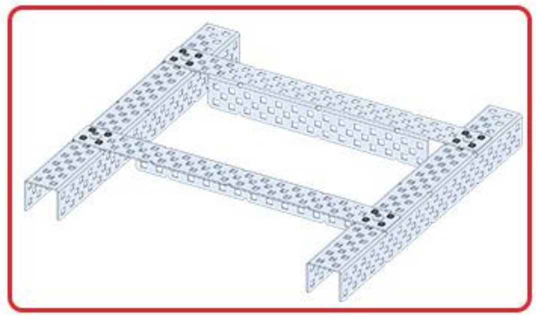


2x - 8-32 Nut

2x - 8-32 x 0.375 in Screw

2x - 4 Post Hex Nut Retainer

1x - Angle 2x2x14x20



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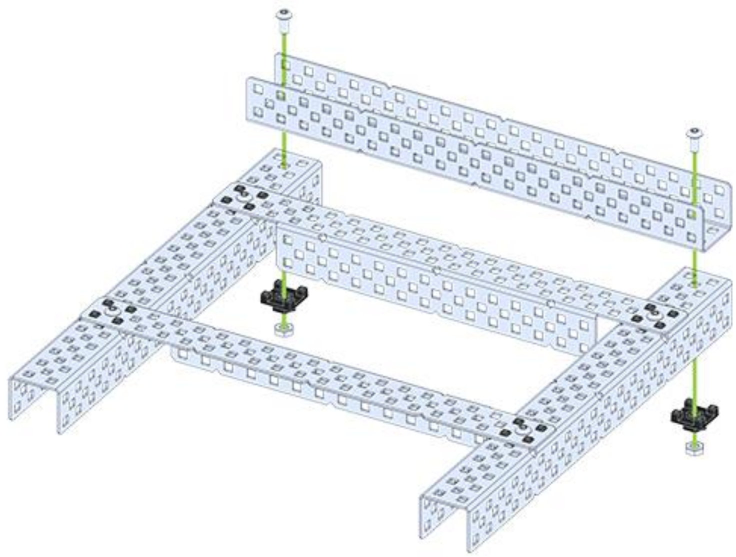
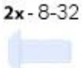


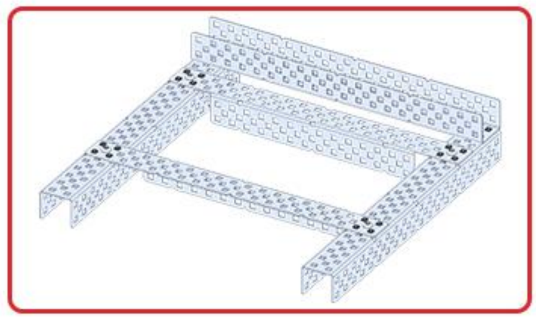
2x - 8-32 Nut



2x - 8-32 x 0.375 in Screw

2x - 4 Post Hex Nut Retainer

1x - 2x2x2x20 U-Channel



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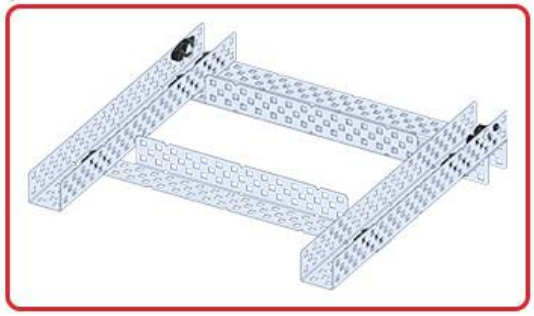
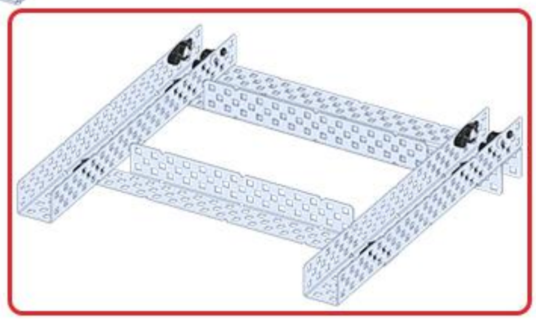


2x - 8-32 Nut

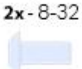
2x - 8-32 x 0.375 in Screw

2x - 1 Post Hex Nut Retainer w/ Bearing Flat

5



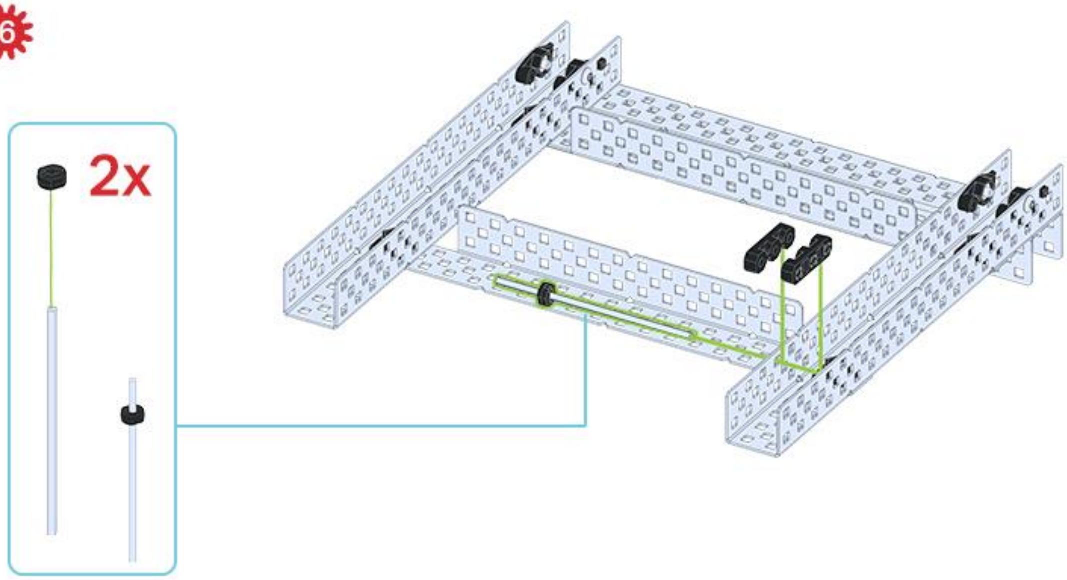
2x - 8-32 Nut



2x - 8-32 x 0.375 in Screw

2x - 1 Post Hex Nut Retainer w/ Bearing Flat

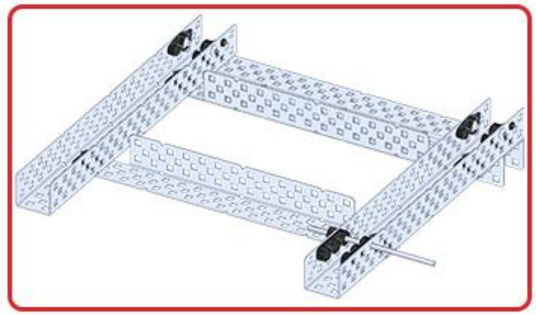
6

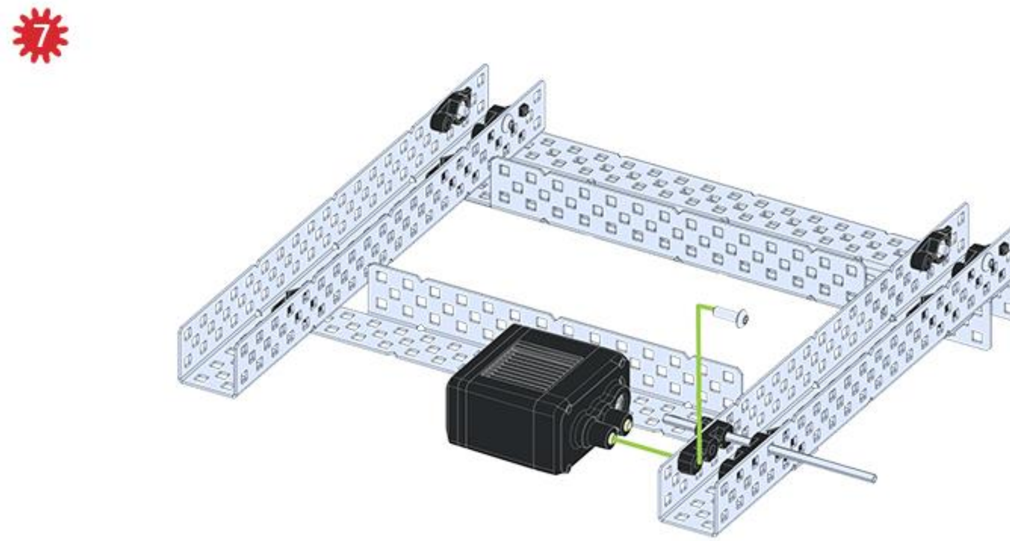


2x - Rubber Shaft Collar

2x - Bearing Flat

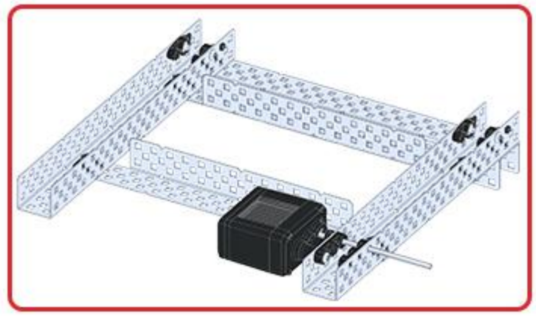
2x - 4 in Shaft





1x - 8-32 x 0.5 in Screw

1x - V5 Smart Motor



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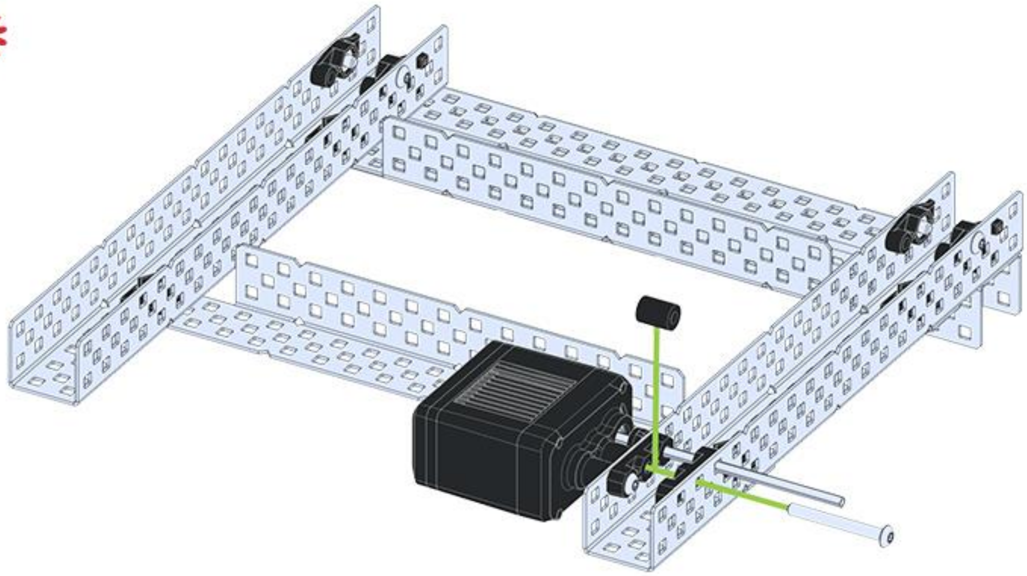
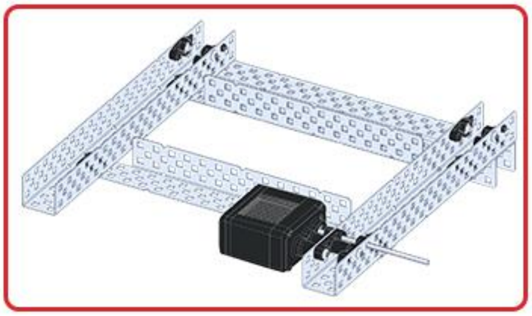
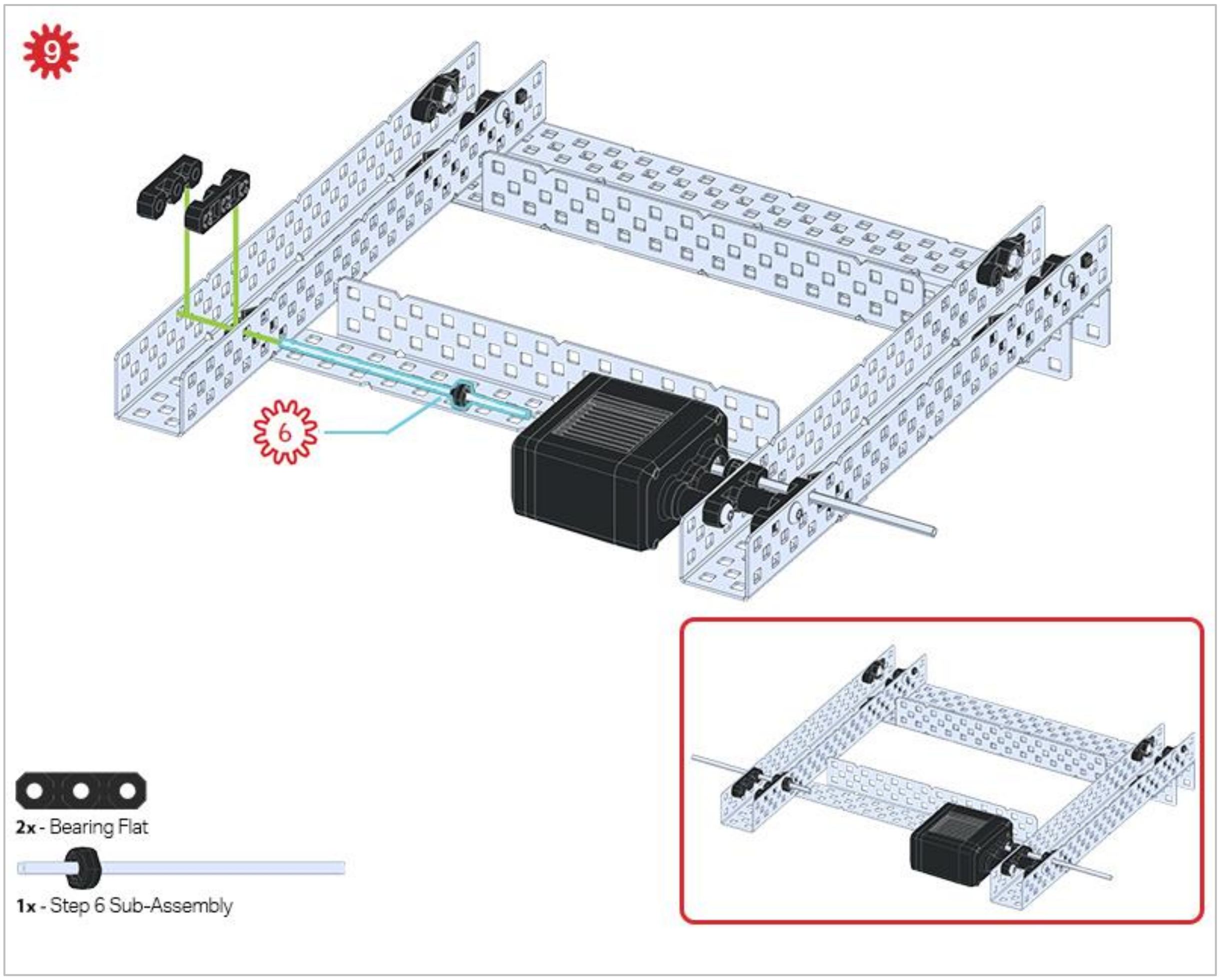
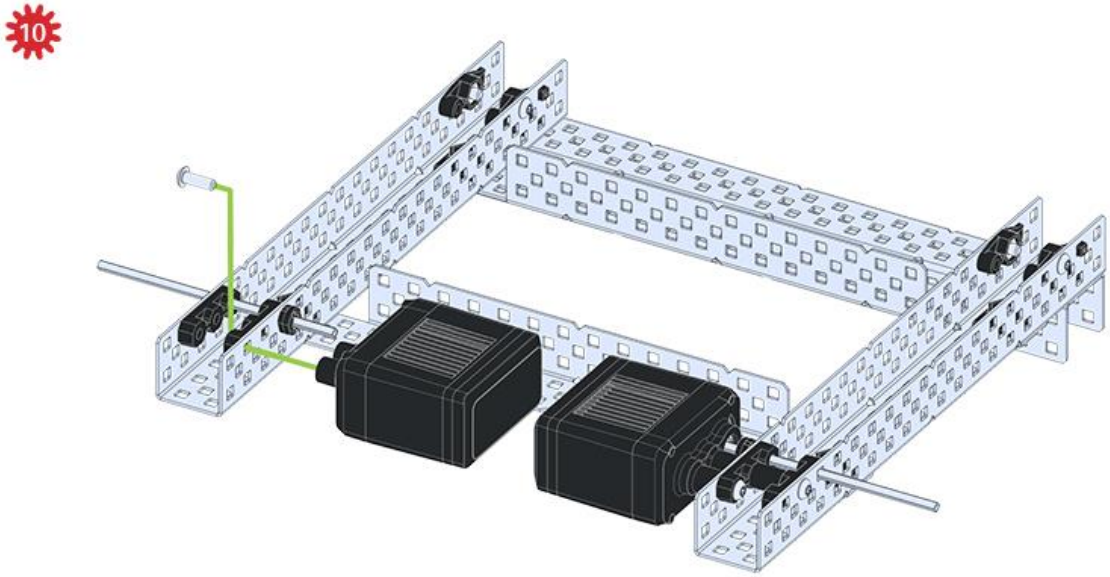




1x - 0.5 in Spacer

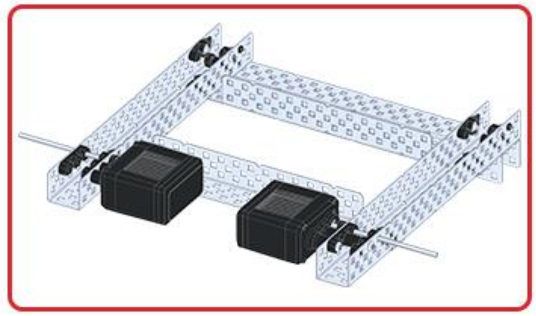
1x - 8-32 x 1.5 in Screw

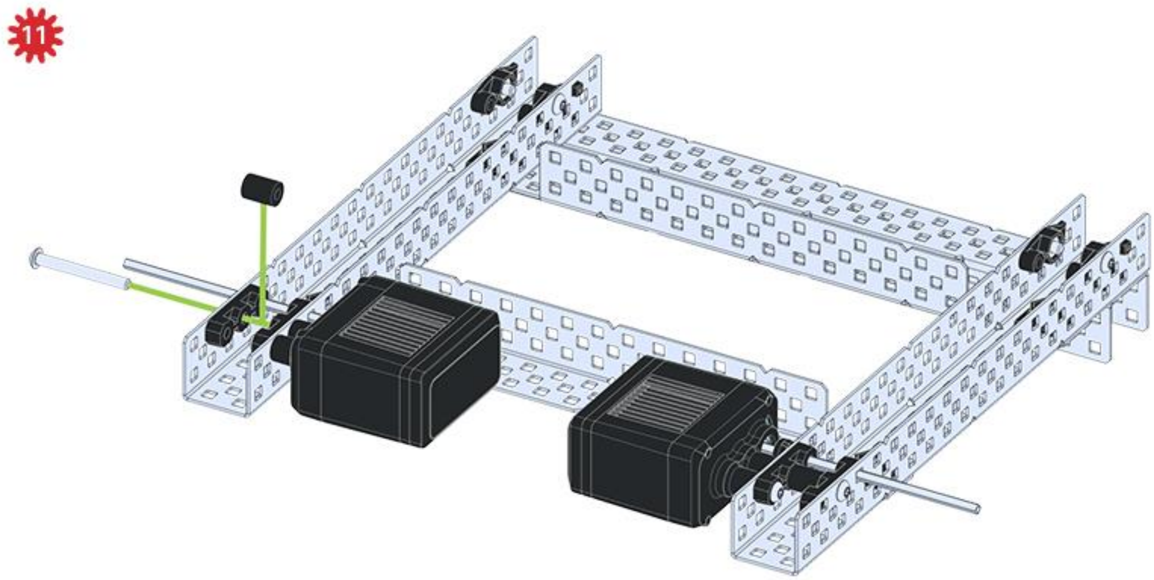

9
6
2x - Bearing Flat
1x - Step 6 Sub-Assembly

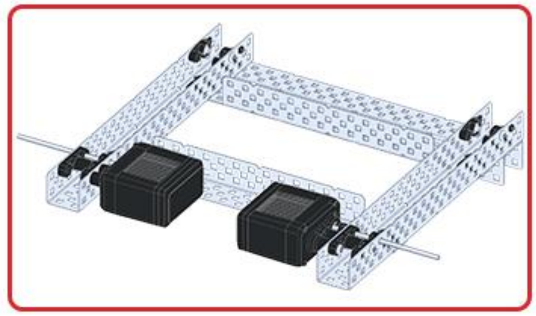


1x - 8-32 x 0.5 in Screw

1x - V5 Smart Motor



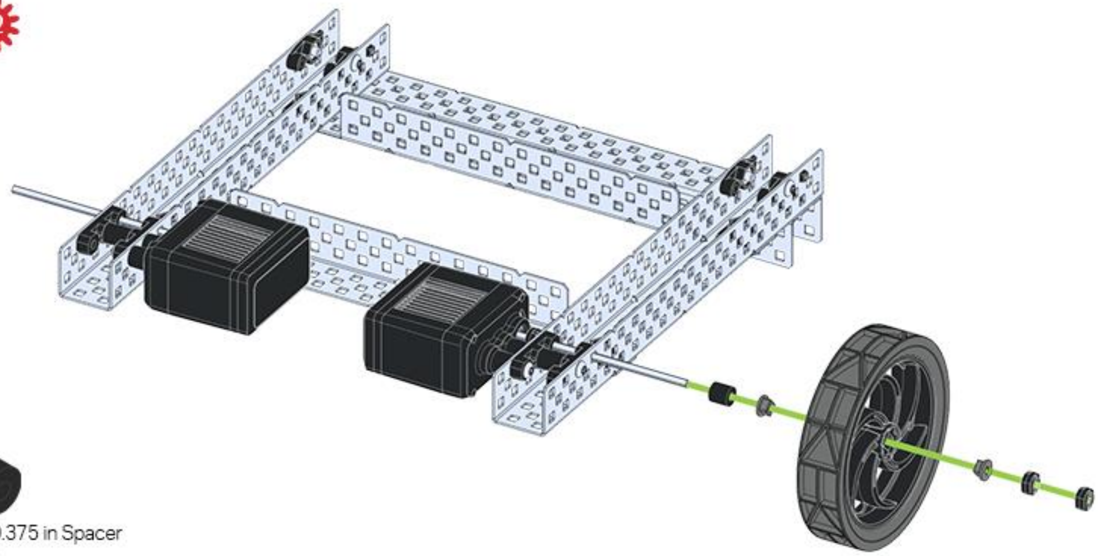




1x - 0.5 in Spacer

1x - 8-32 x 1.5 in Screw

12

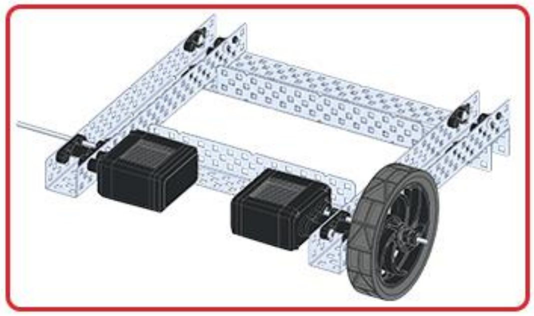


1x - 0.375 in Spacer

2x - Rubber Shaft Collar

1x - 4 in Wheel

2x - High Strength Shaft Insert



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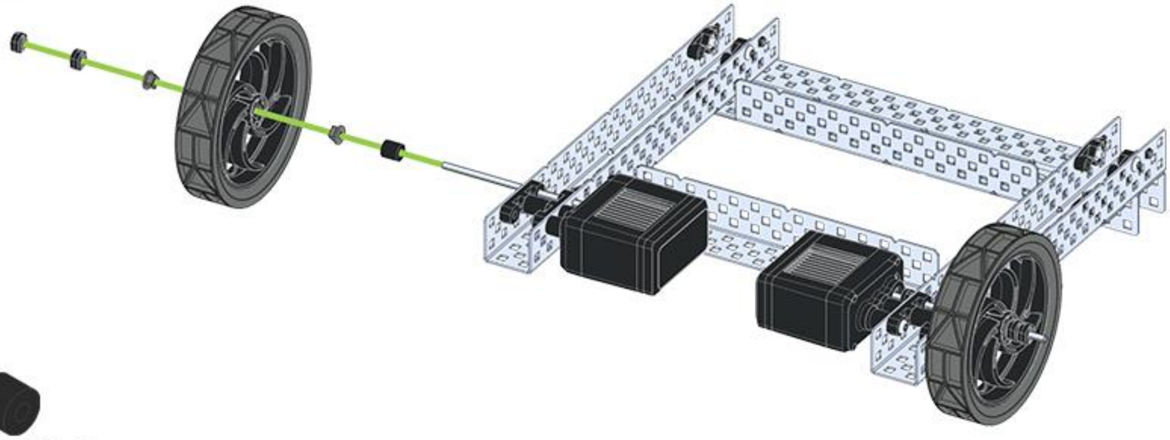
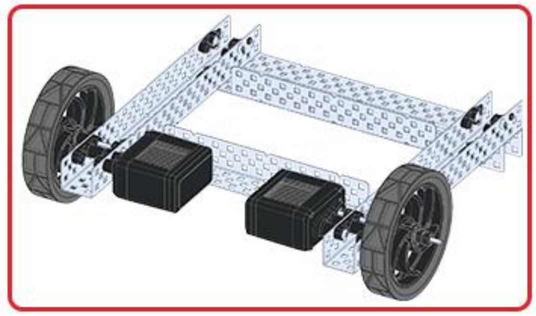


1x - 0.375 in Spacer

2x - Rubber Shaft Collar

1x - 4 in Wheel

2x - High Strength Shaft Insert



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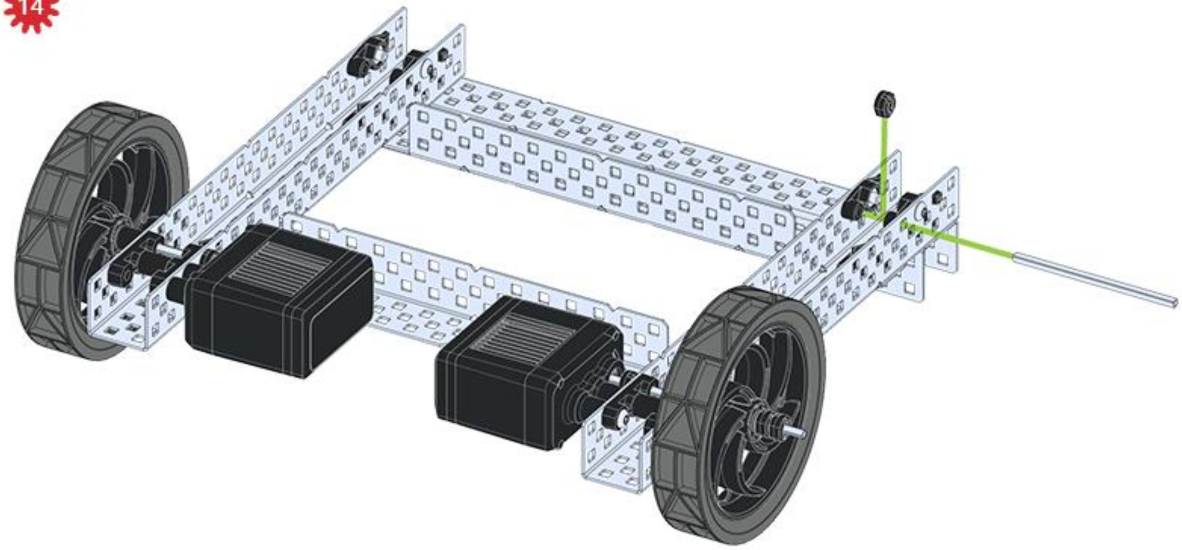
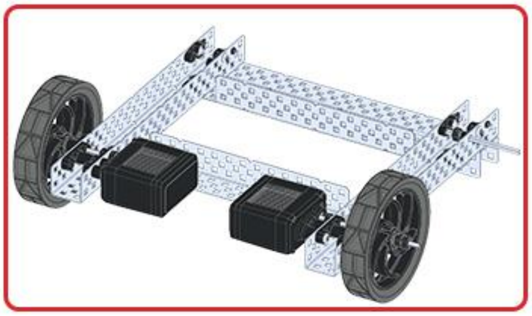
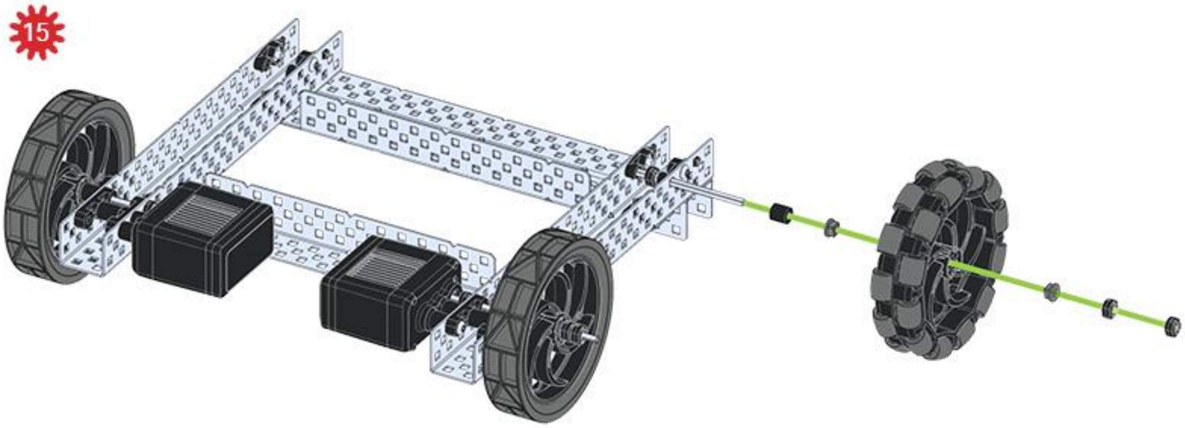


1x - Rubber Shaft Collar

1x - 3 in Shaft



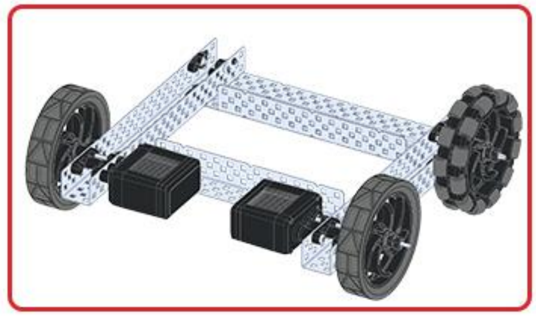


1x - 0.375 in Spacer

2x - Rubber Shaft Collar

1x - 4 in Omni Wheel

2x - High Strength Shaft Insert



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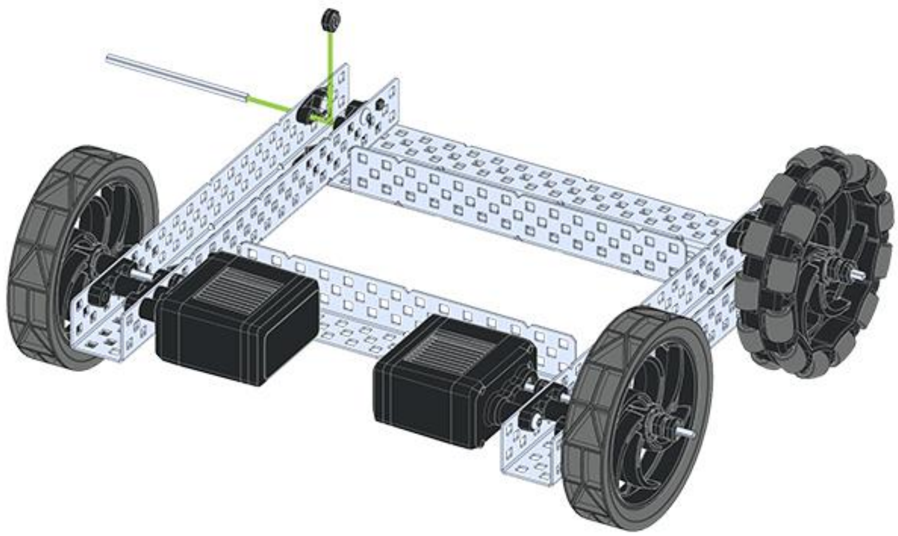
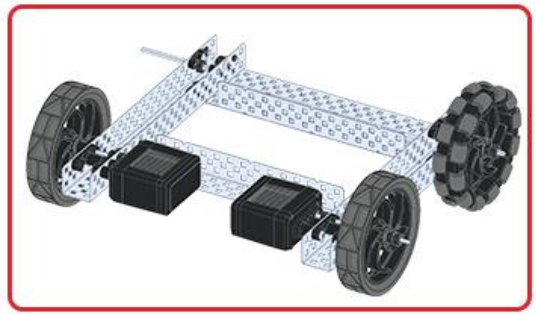
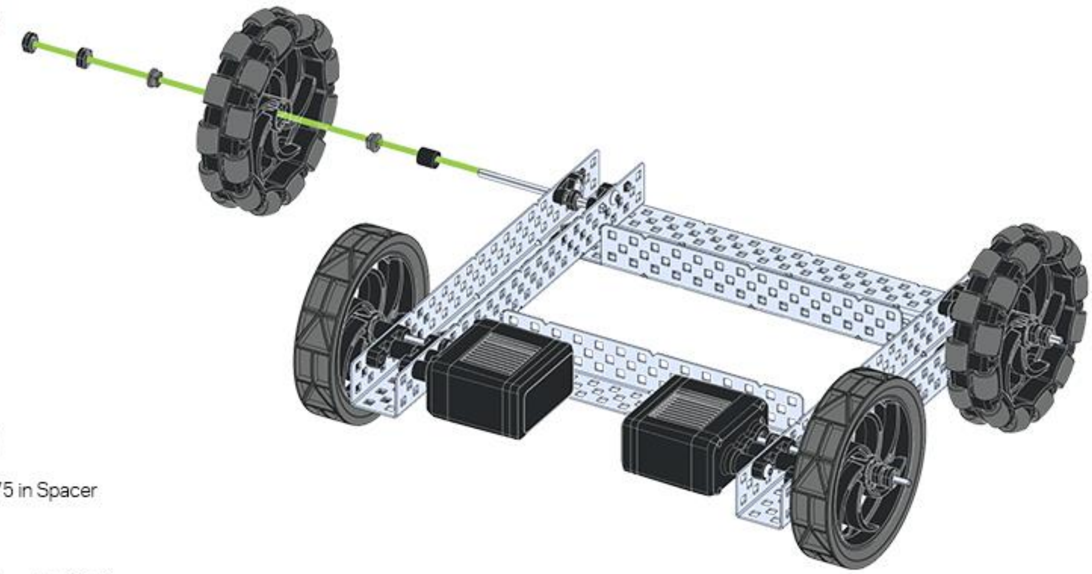


1x - Rubber Shaft Collar

1x - 3 in Shaft



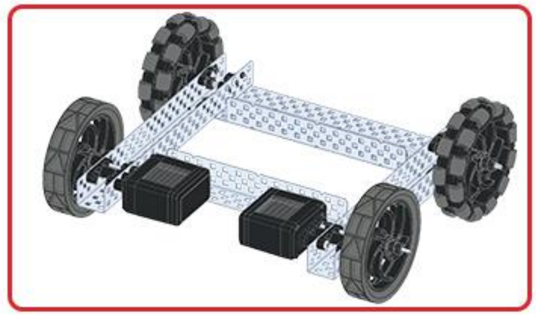


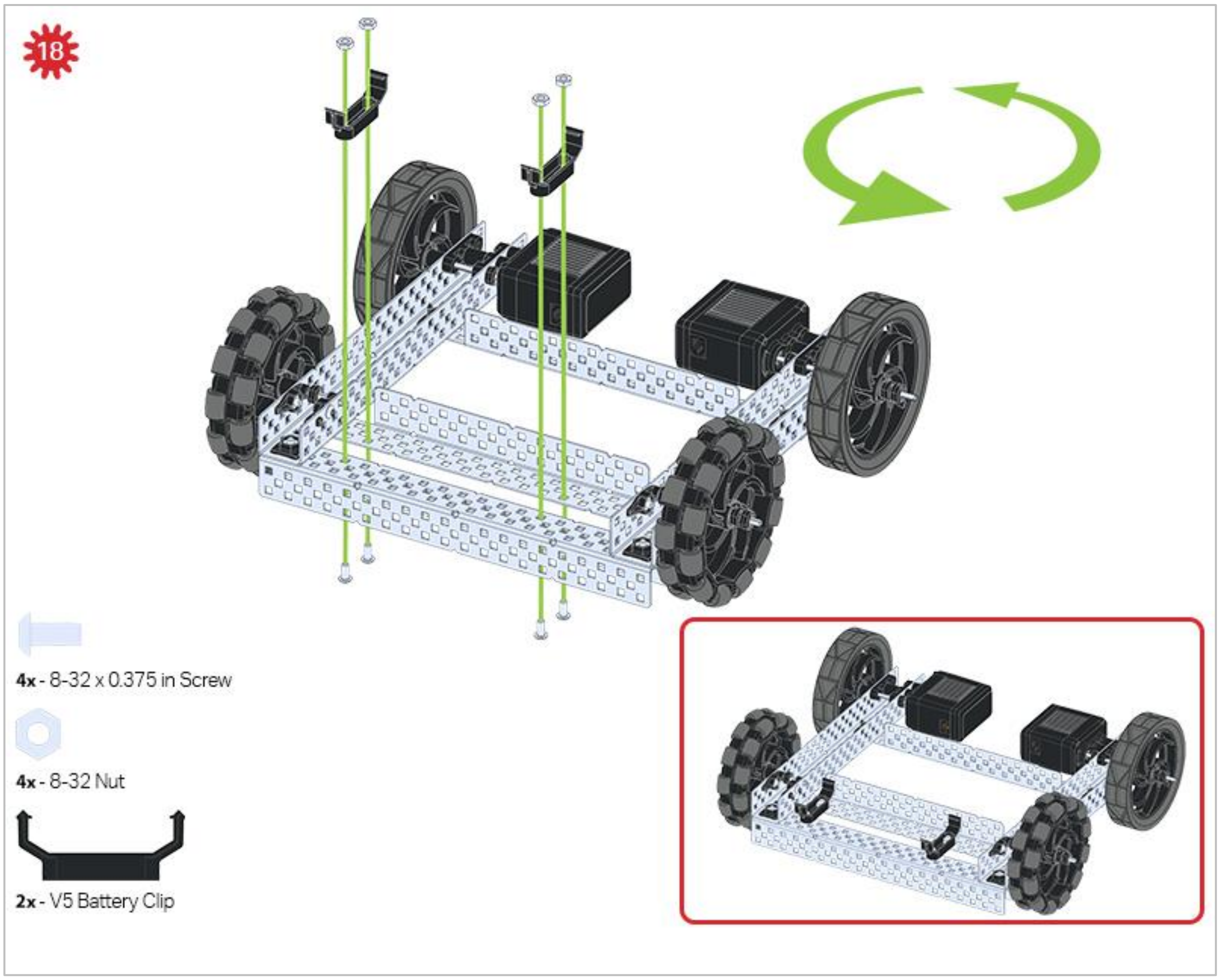
1x - 0.375 in Spacer

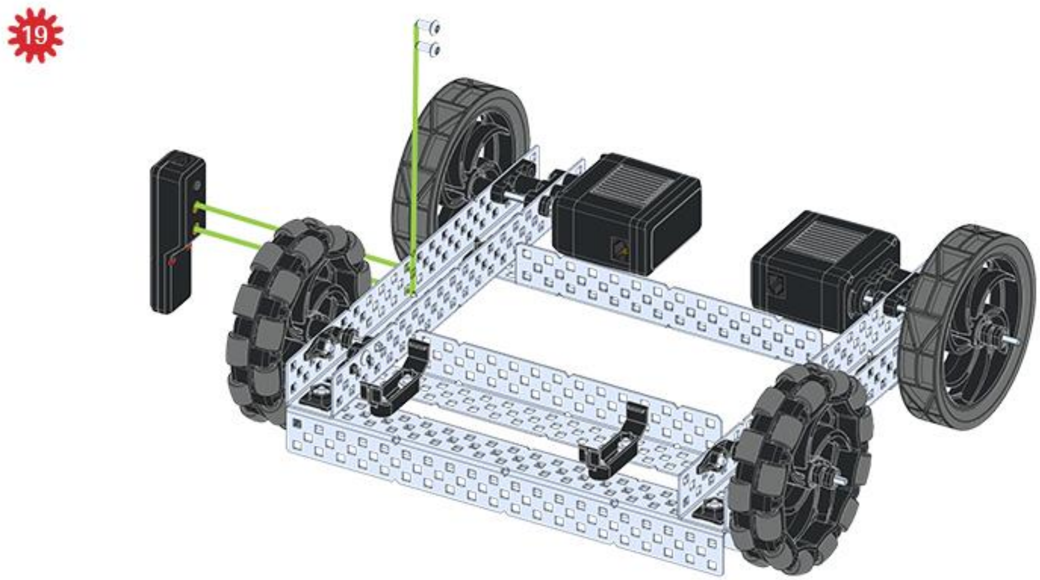
2x - Rubber Shaft Collar

1x - 4 in Omni Wheel

2x - High Strength Shaft Insert

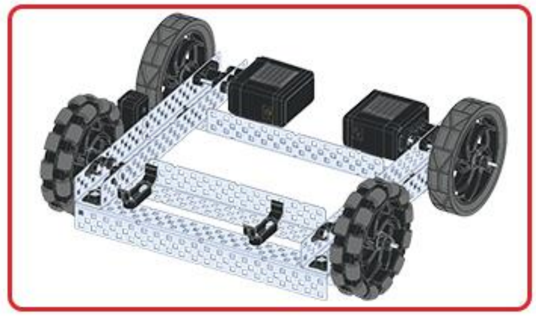


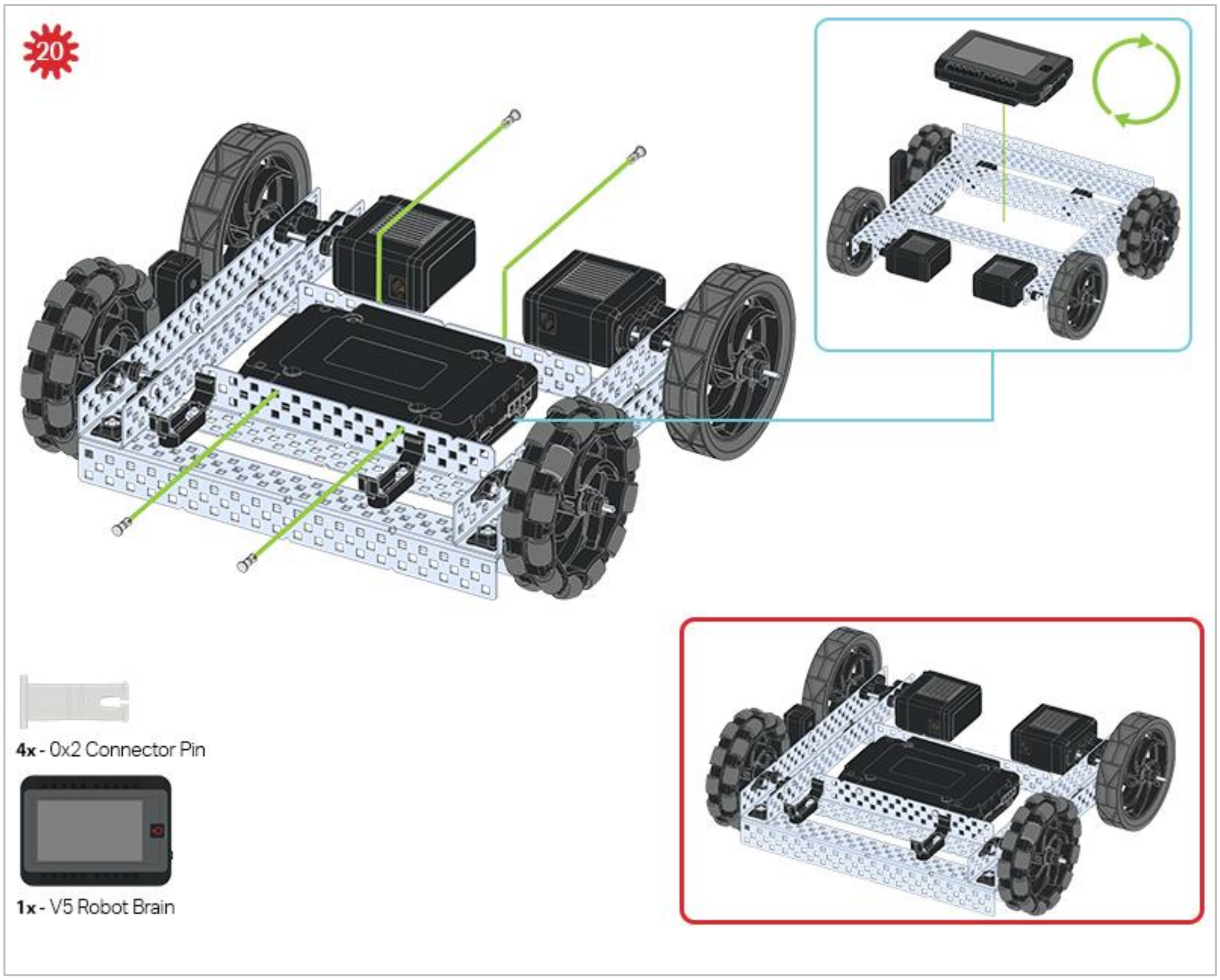

18
4x - 8-32 x 0.375 in Screw
4x - 8-32 Nut
2x - V5 Battery Clip



1x - V5 Radio

2x - 8-32 x 0.375 in Screw

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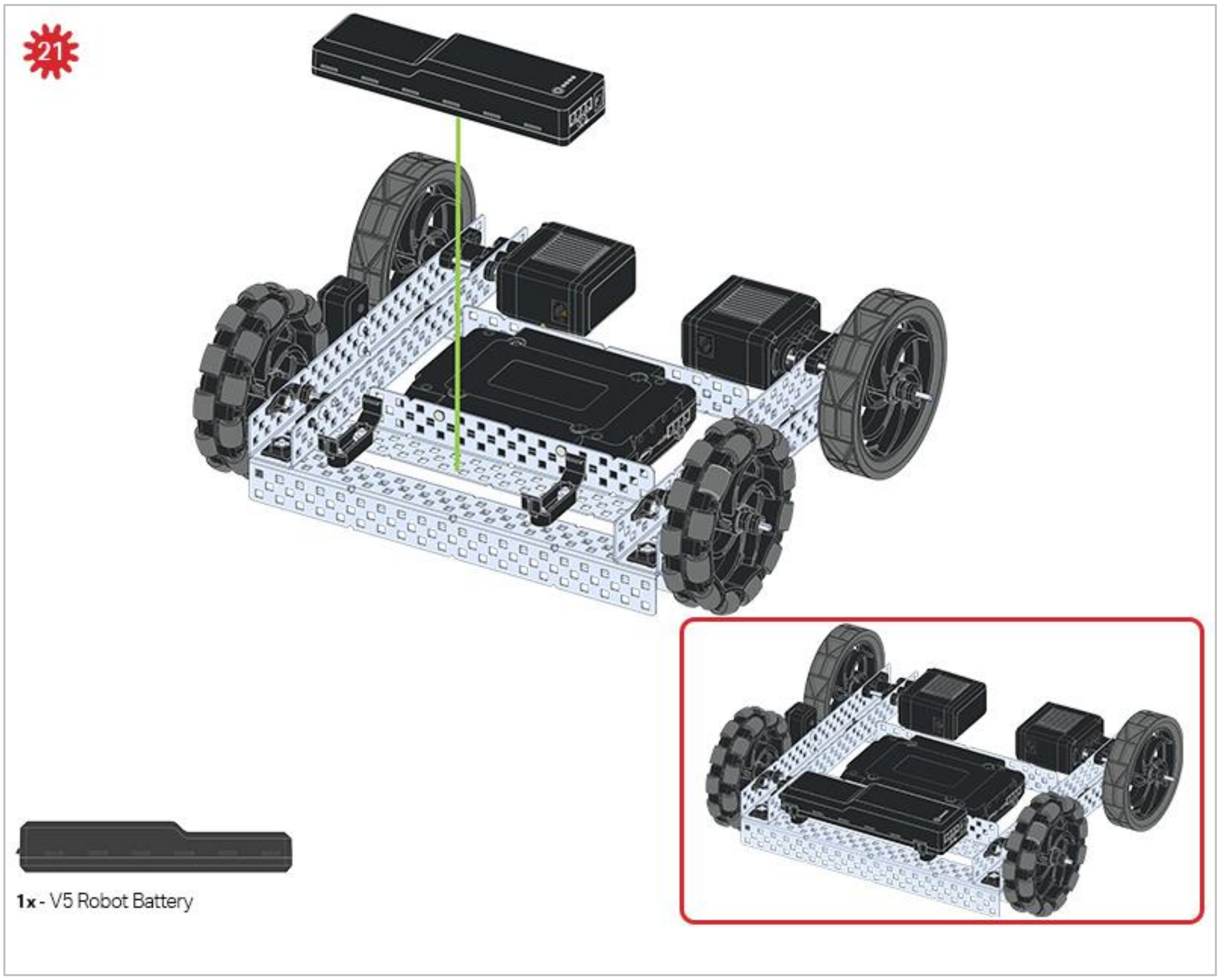
4x - 0x2 Connector Pin
1x - V5 Robot Brain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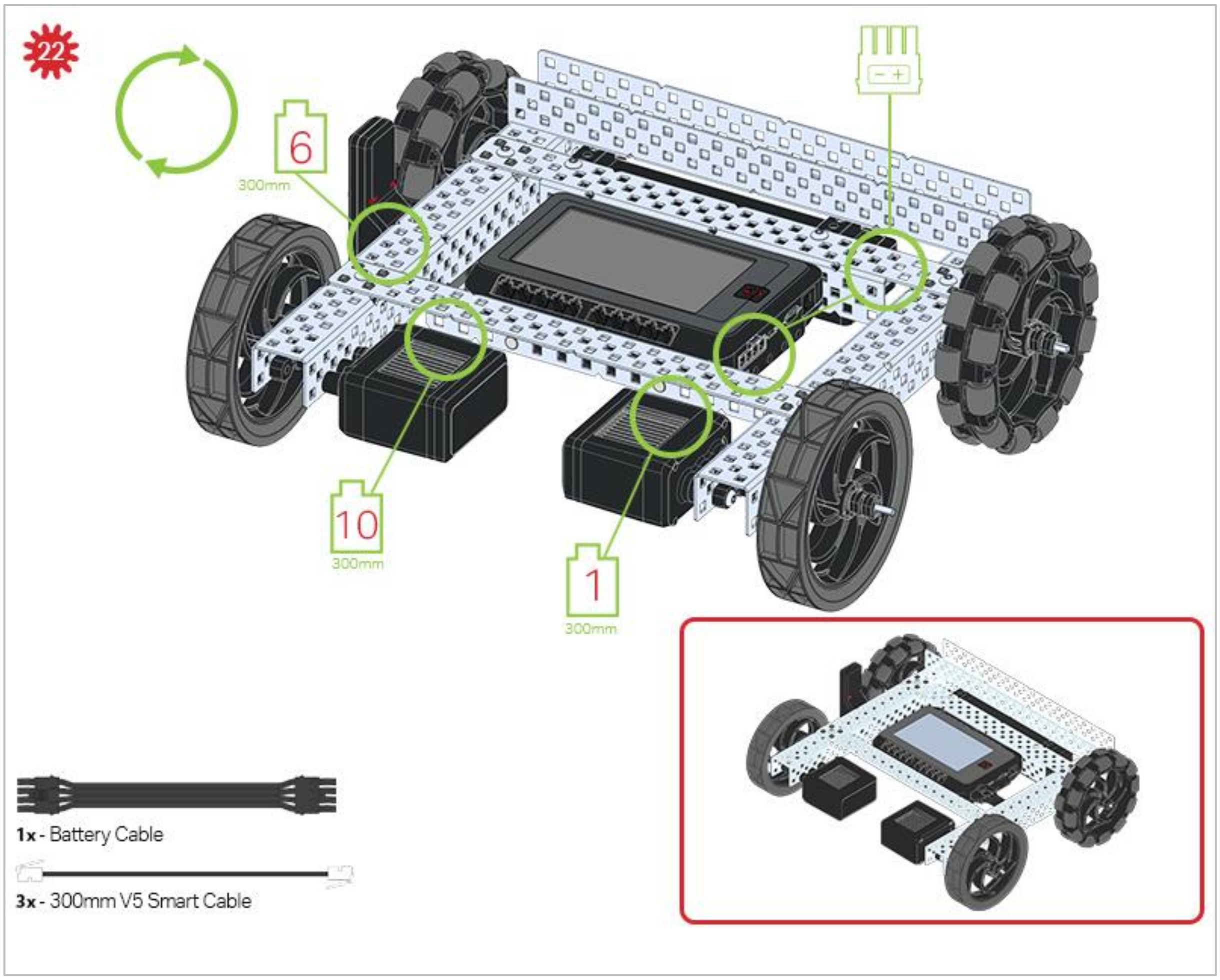
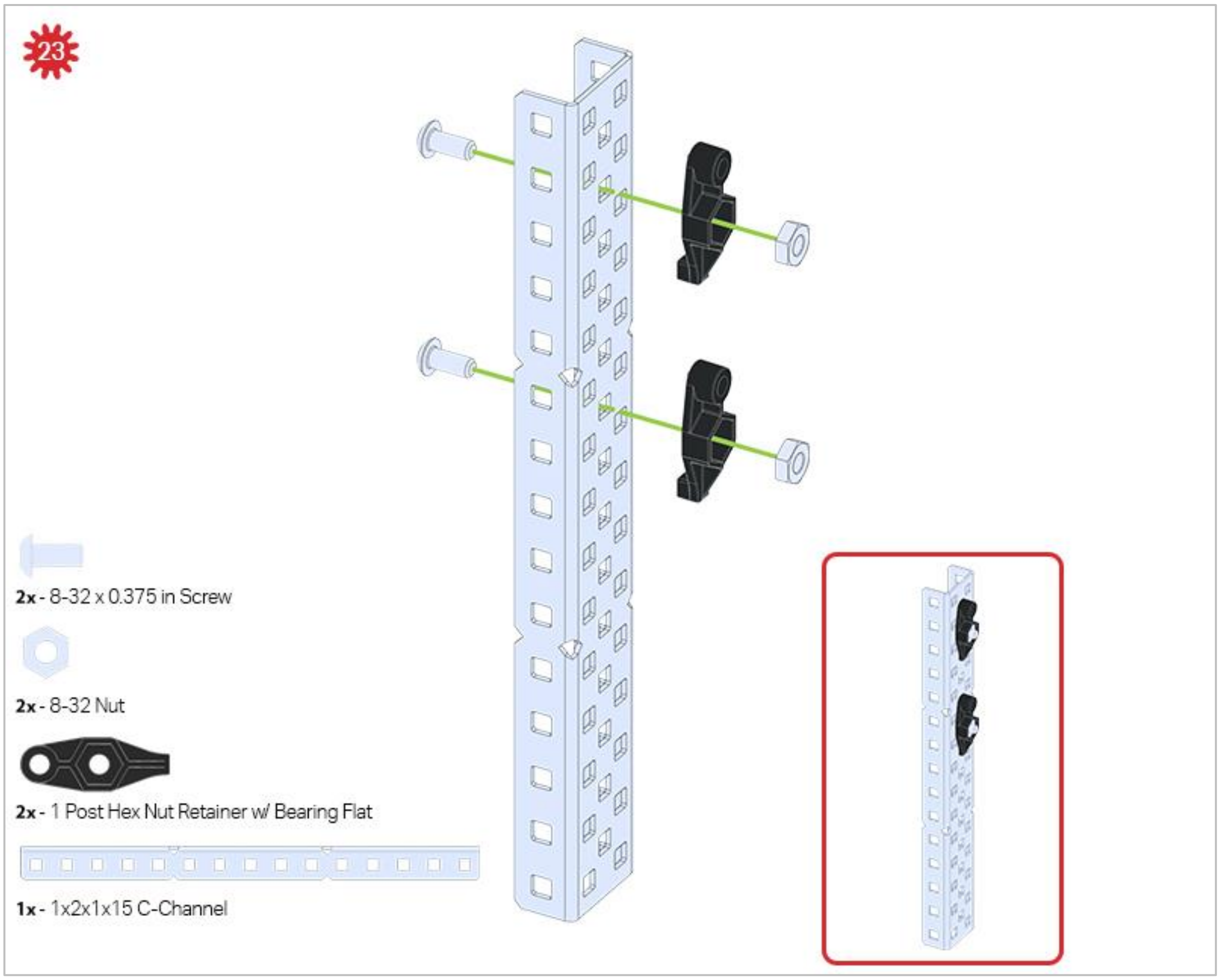
1x - V5 Robot Battery


22
6
300mm
10
300mm
1
300mm
1x - Battery Cable
3x - 300mm V5 Smart Cable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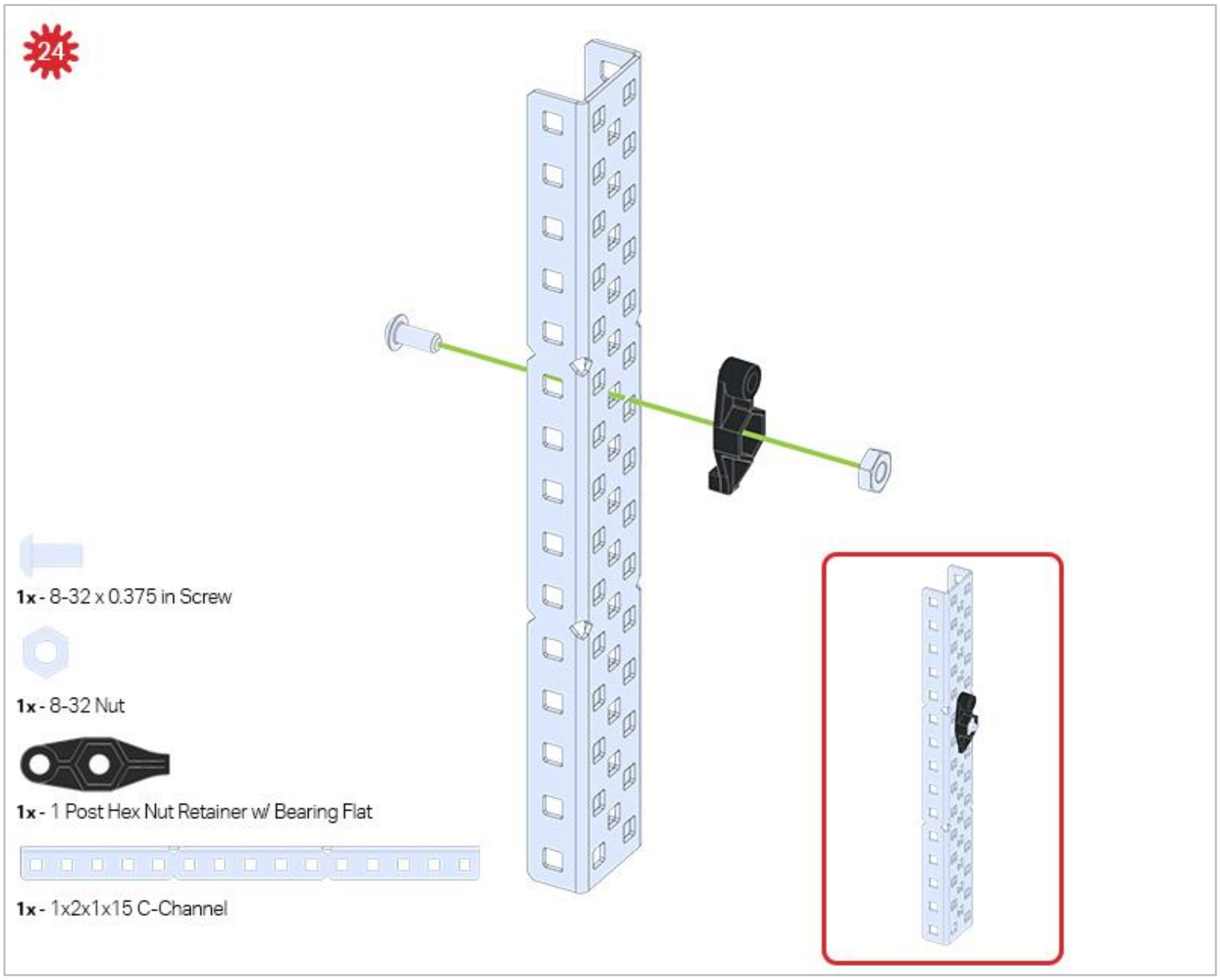
2x - 8-32 x 0.375 in Screw
2x - 8-32 Nut
2x - 1 Post Hex Nut Retainer w/ Bearing Flat
1x - 1x2x1x15 C-Channel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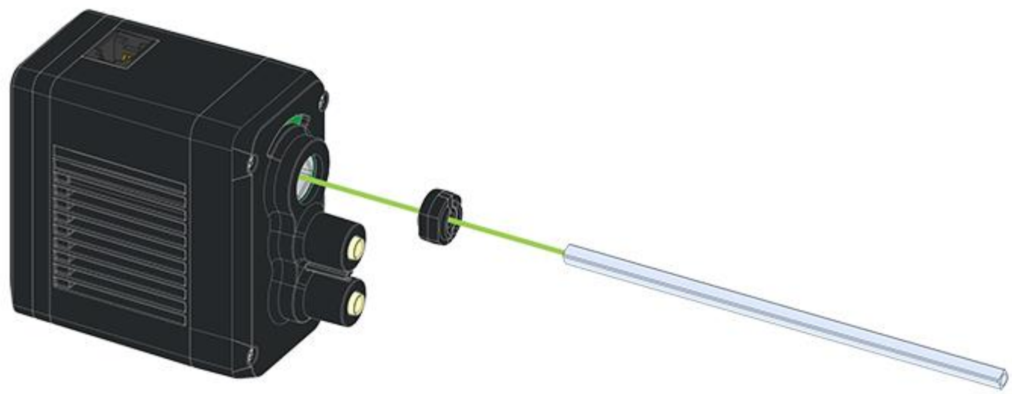
1x - 8-32 x 0.375 in Screw
1x - 8-32 Nut
1x - 1 Post Hex Nut Retainer w/ Bearing Flat
1x - 1x2x1x15 C-Channel

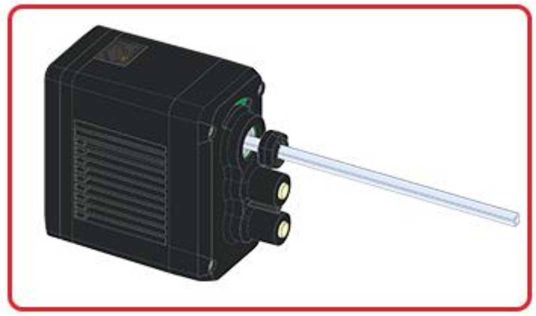
25

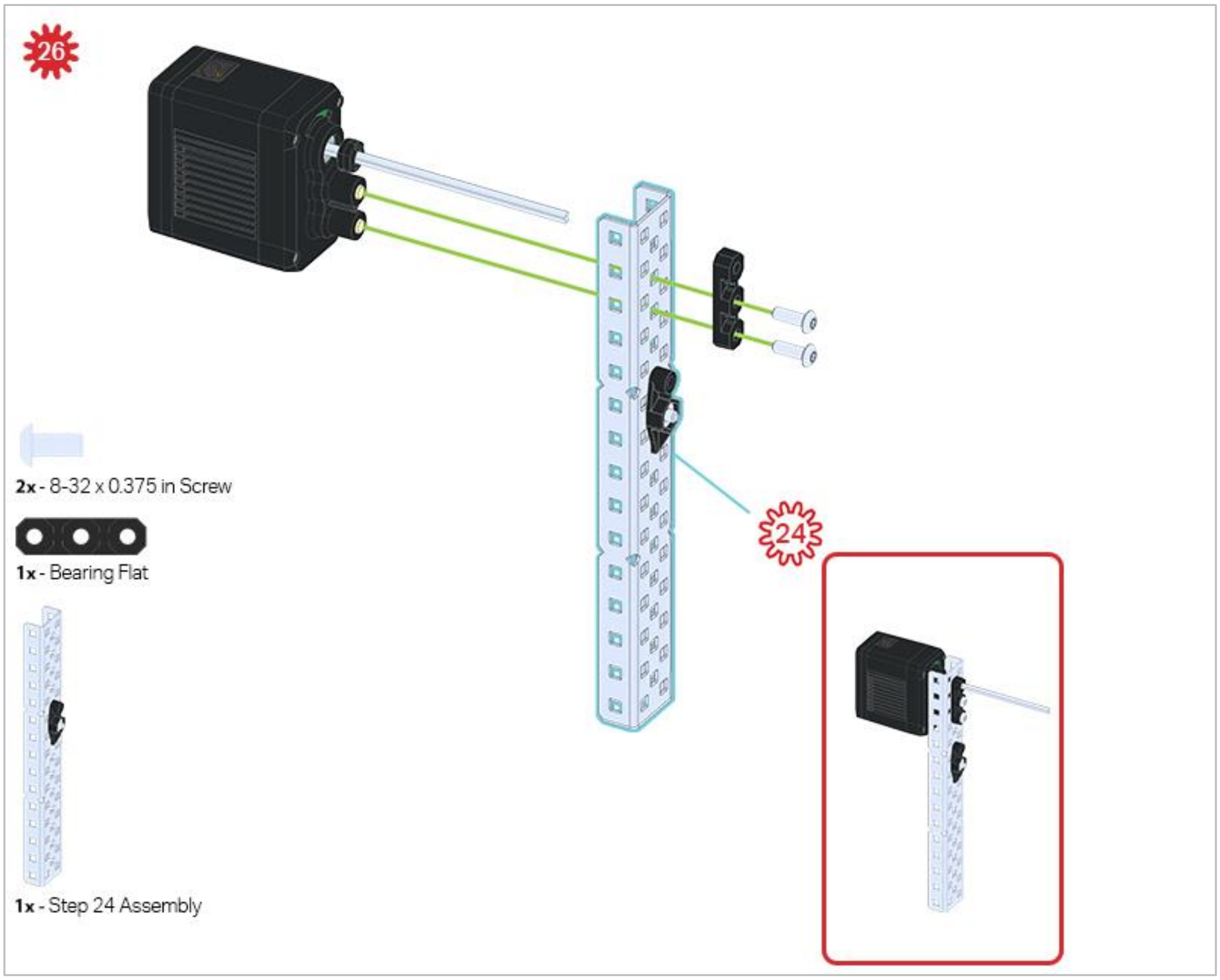


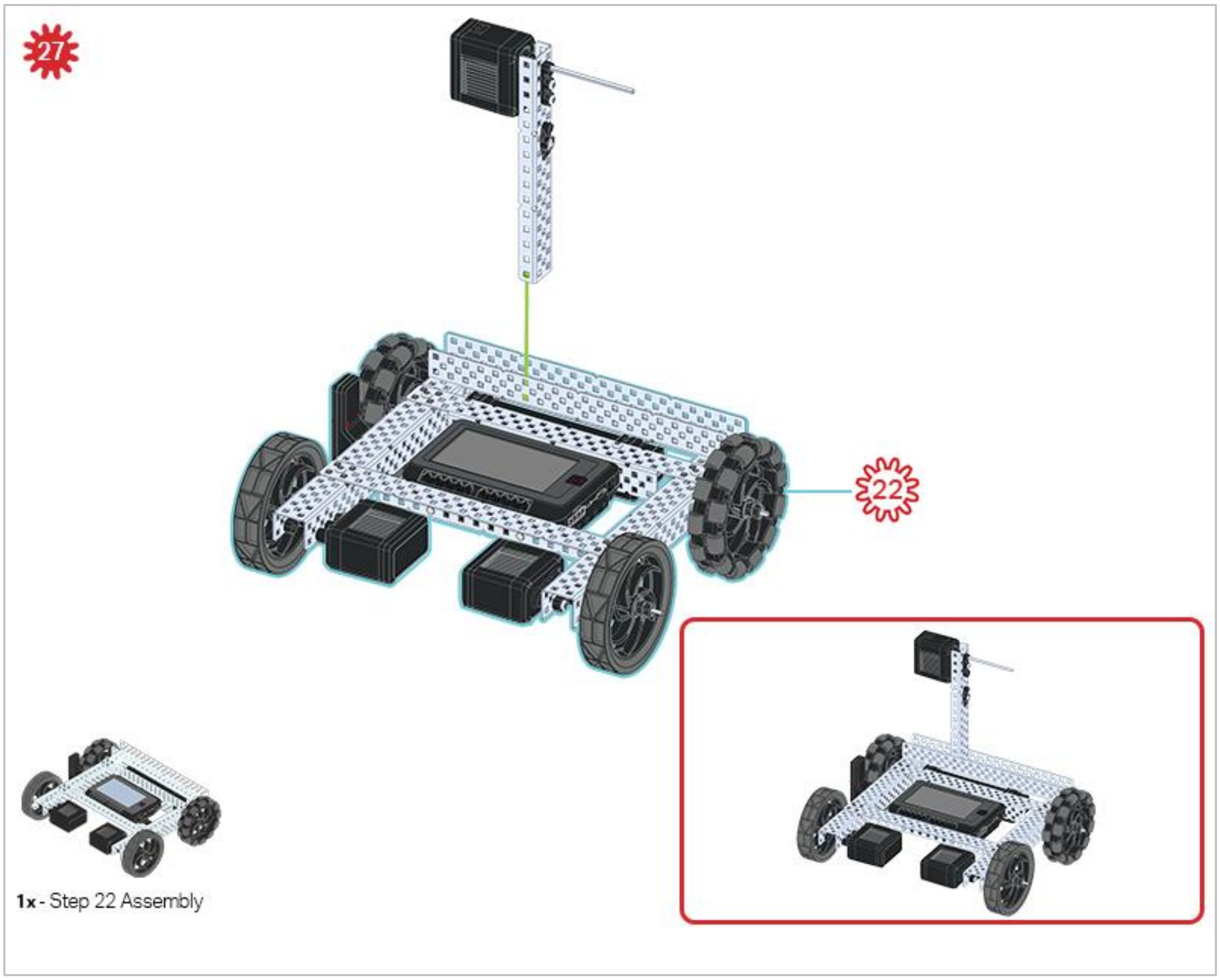
1x - Rubber Shaft Collar

1x - V5 Smart Motor

1x - 4 in Shaft




26
2x - 8-32 x 0.375 in Screw
1x - Bearing Flat
1x - Step 24 Assembly
24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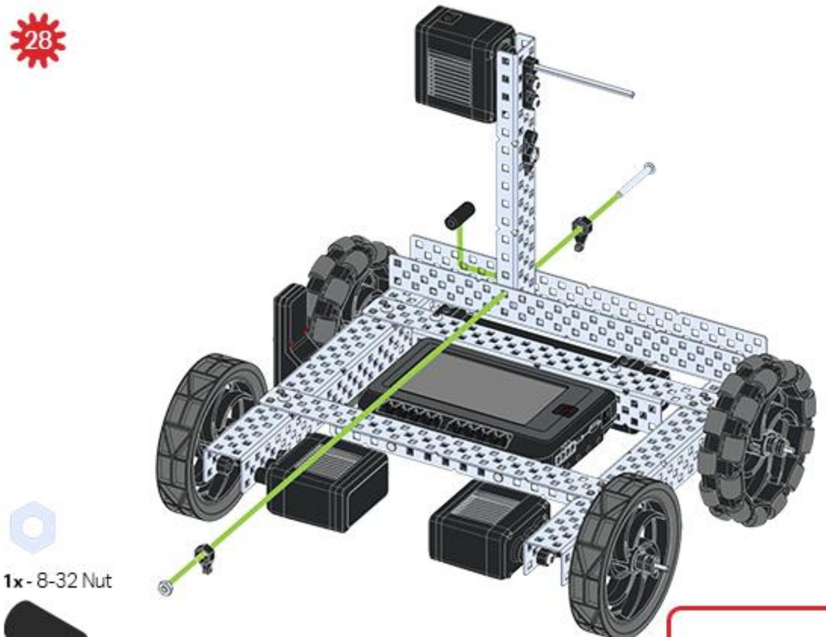
22
1x - Step 22 Assembly

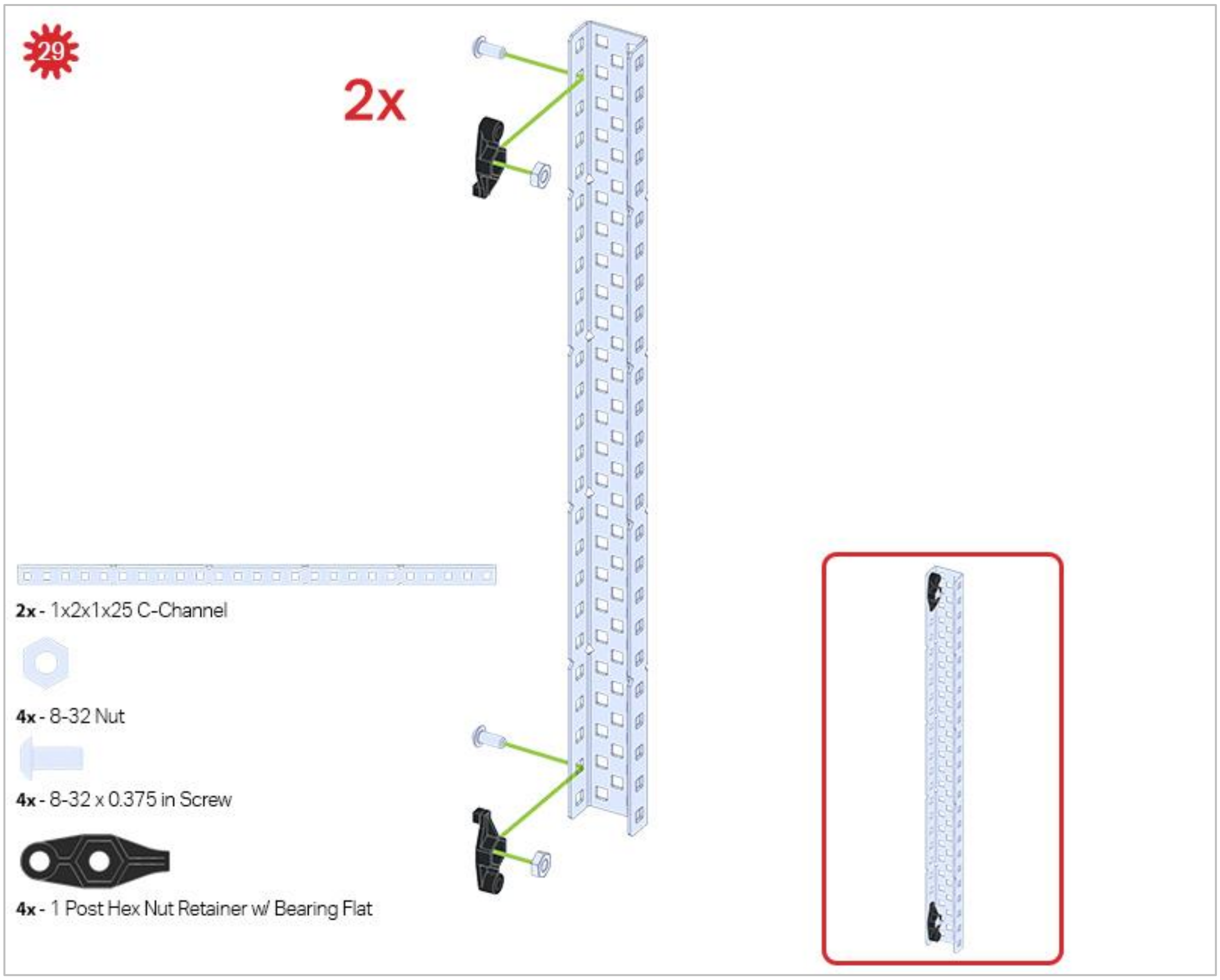


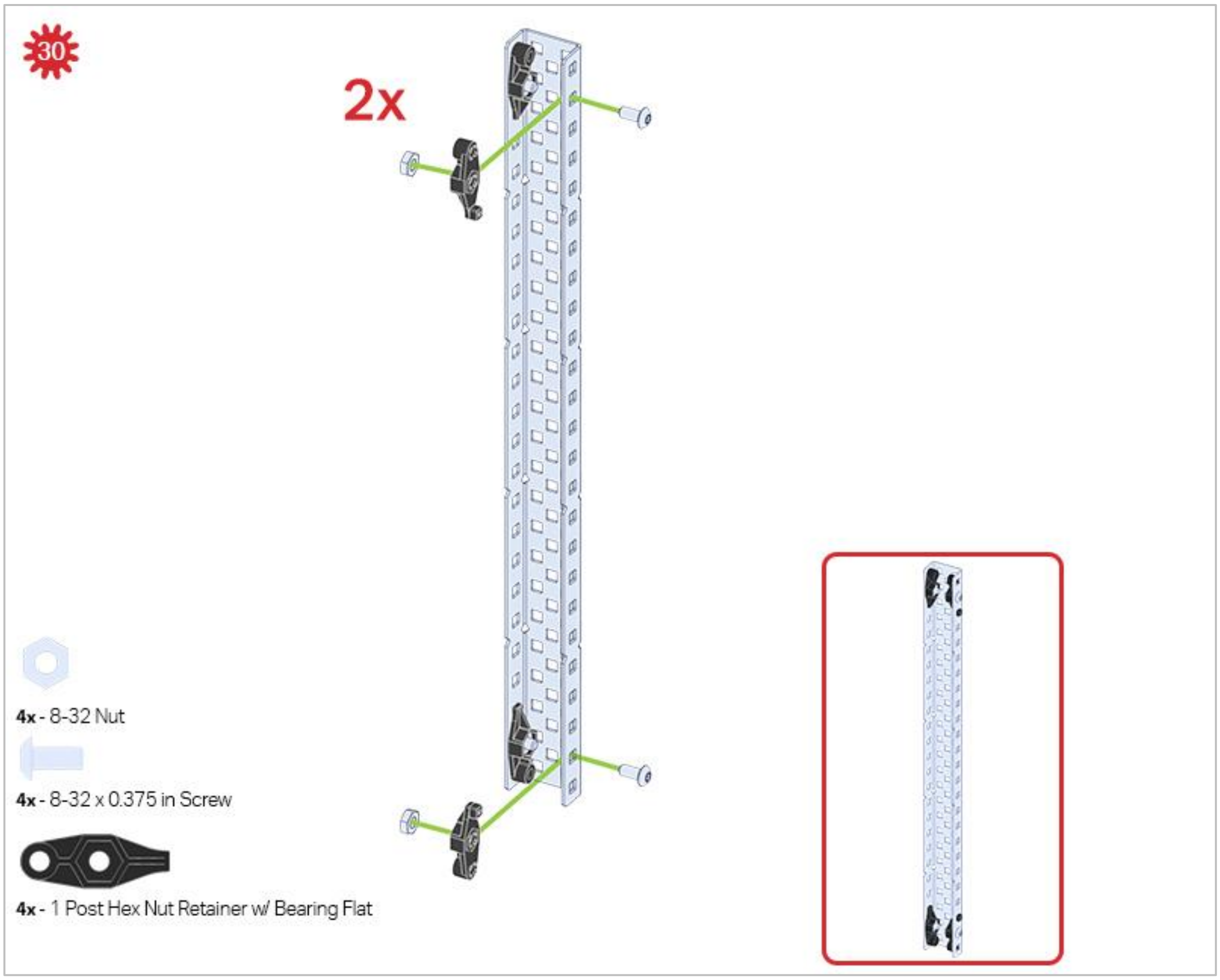
1x - 8-32 Nut

1x - 0.875 in Spacer

2x - 1 Post Hex Nut Retainer

1x - 8-32 x 1.5 in Screw


29
2x
2x - 1x2x1x25 C-Channel
4x - 8-32 Nut
4x - 8-32 x 0.375 in Screw
4x - 1 Post Hex Nut Retainer w/ Bearing Flat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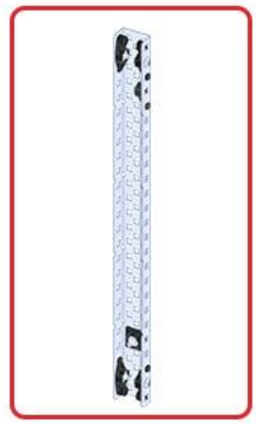
2x
4x - 8-32 Nut
4x - 8-32 x 0.375 in Screw
4x - 1 Post Hex Nut Retainer w/ Bearing Flat


31
1x - 0.5 in Spacer
1x - 8-32 Nut
1x - 4 Post Hex Nut Retainer
1x - 8-32 x 1 in Screw

32

1x - 8-32 Nut

1x - 1 Post Hex Nut Retainer



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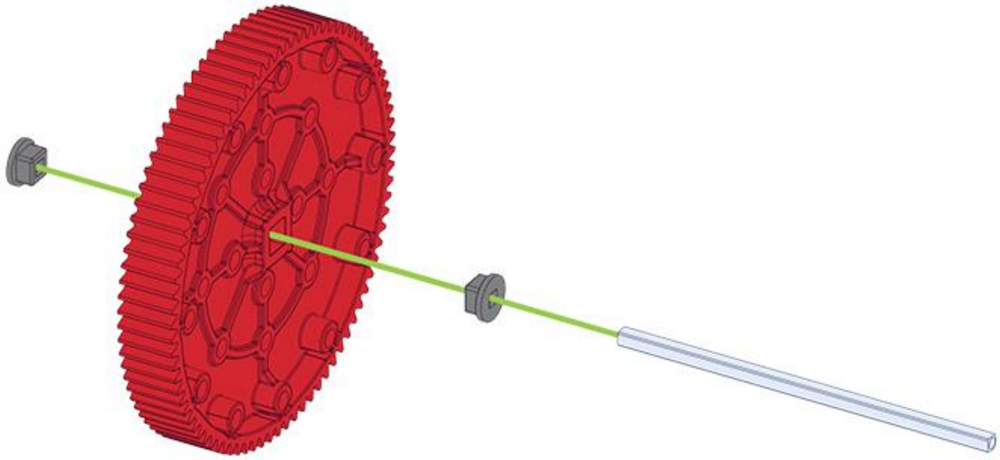
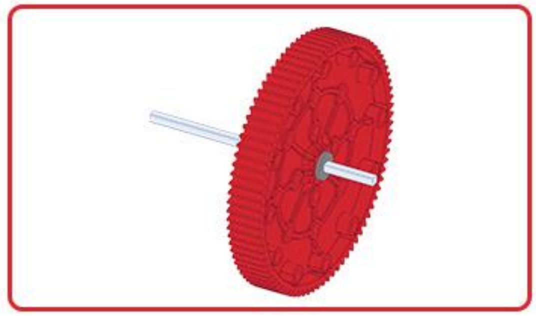


1x - High Strength 84 Tooth Gear

2x - High Strength Shaft Insert

1x - 3.5 in Shaft



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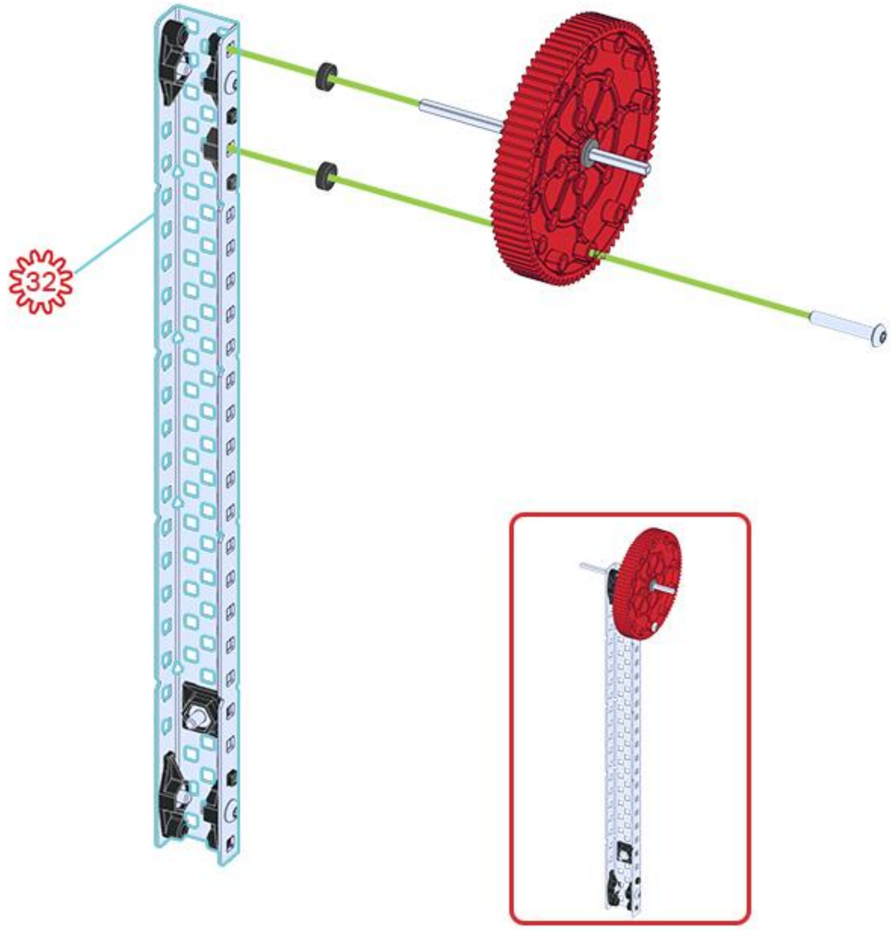
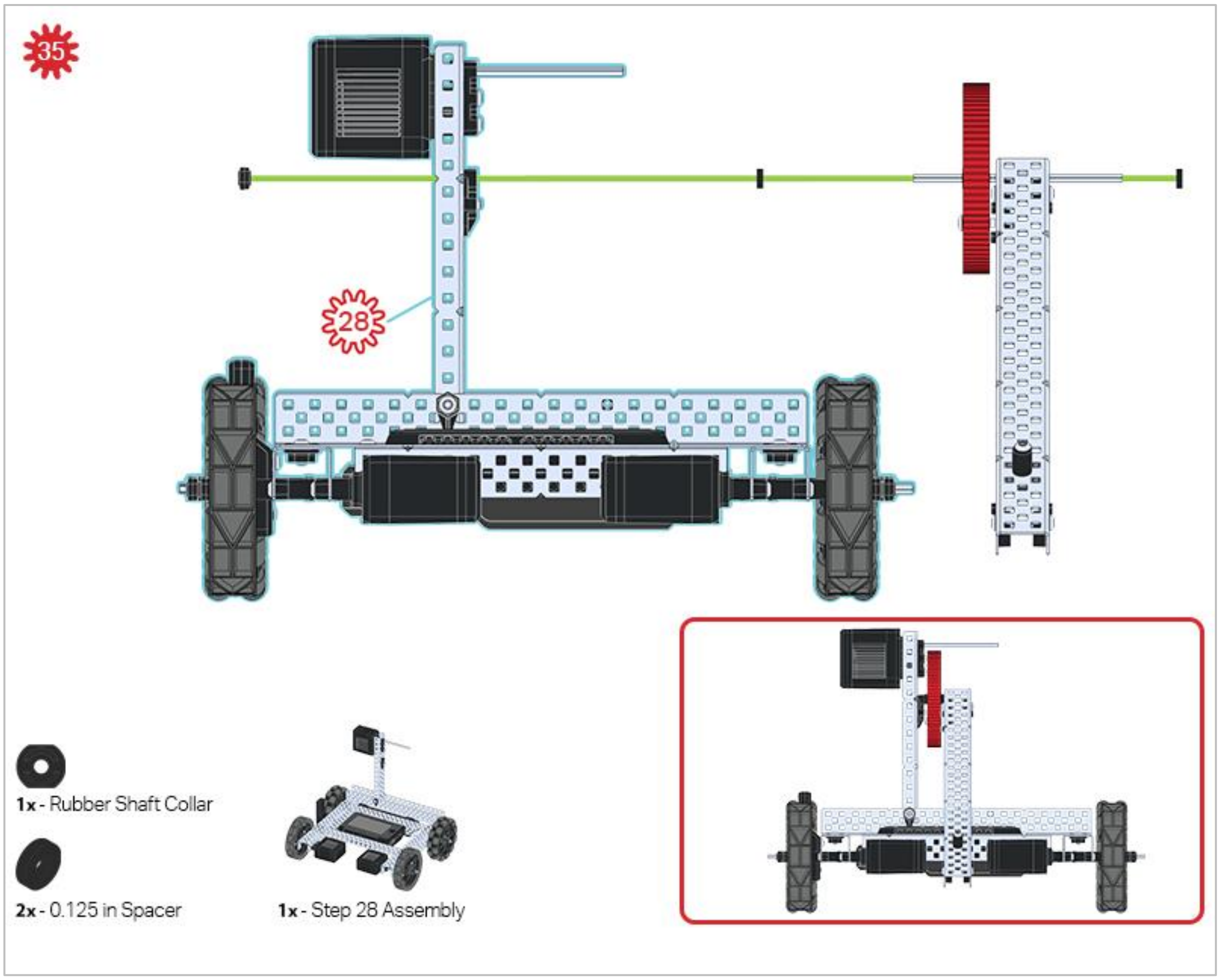
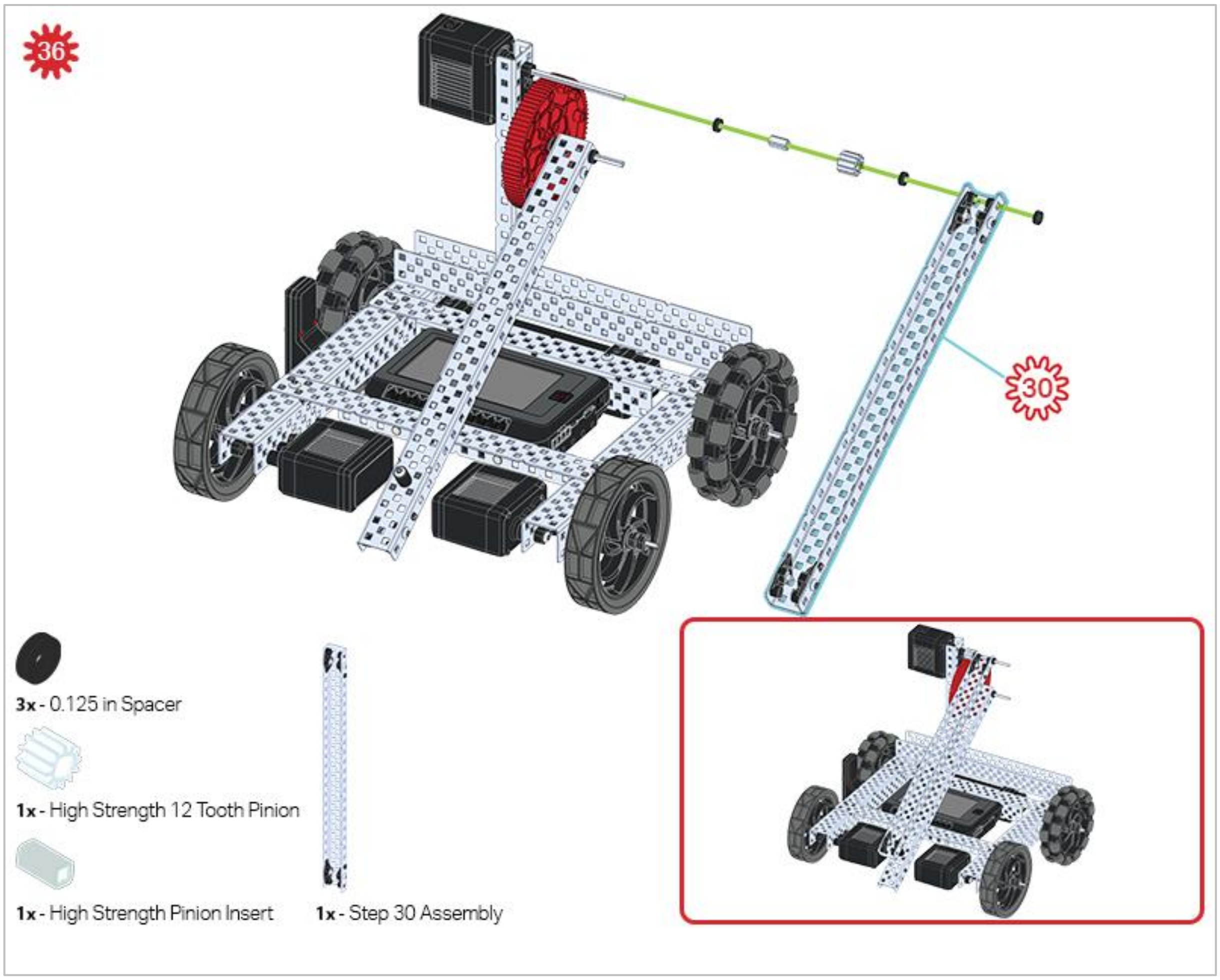


1x - Step 32 Assembly

2x - 0.125 in Spacer

1x - 8-32 x 1 in Screw


35
28
1x - Rubber Shaft Collar
2x - 0.125 in Spacer
1x - Step 28 Assembly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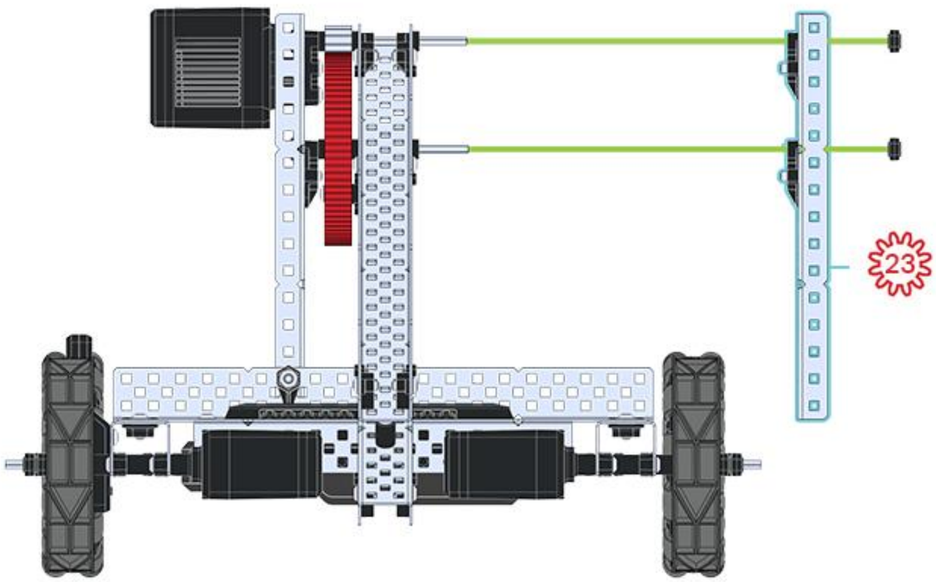
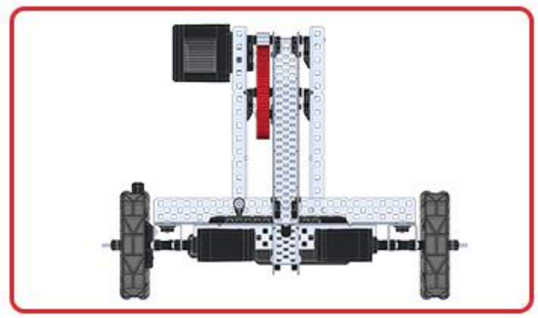
3x - 0.125 in Spacer
1x - High Strength 12 Tooth Pinion
1x - High Strength Pinion Insert
1x - Step 30 Assembly

37



1x - Step 23 Assembly

2x - Rubber Shaft Collar



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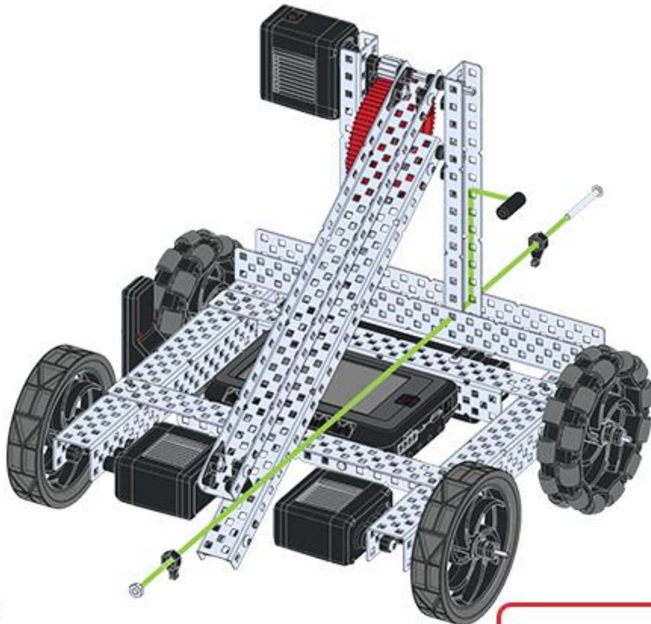


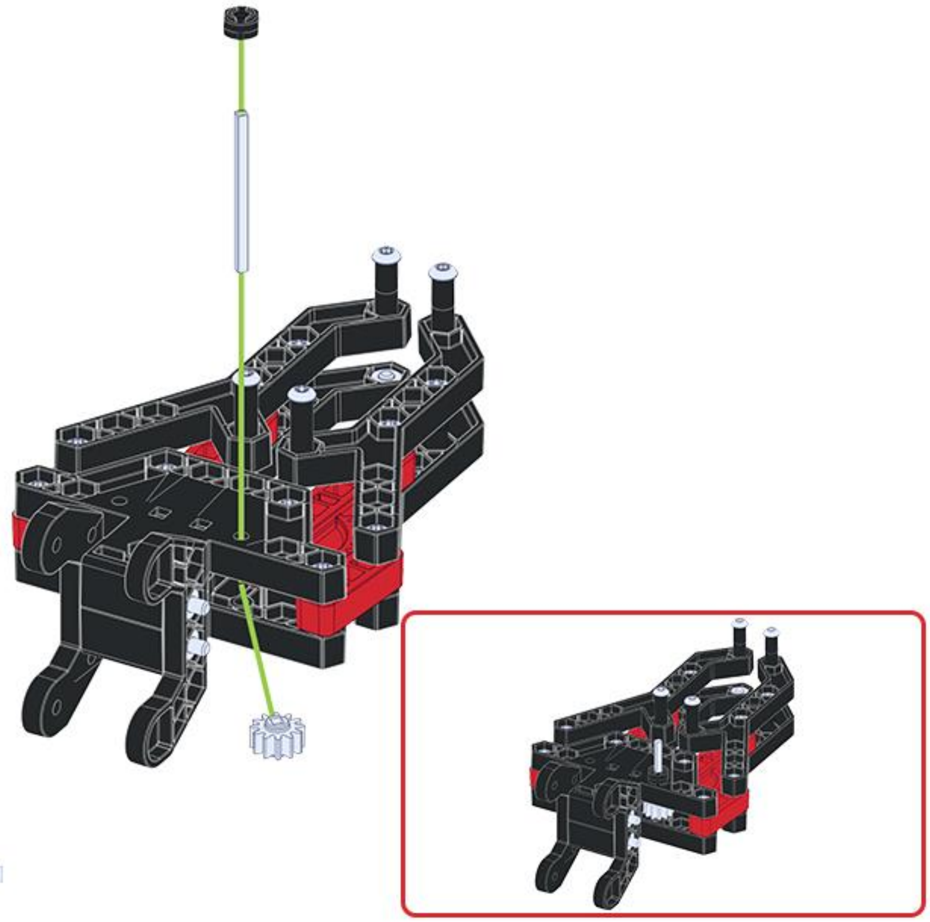
1x - 0.875 in Spacer

1x - 8-32 Nut

2x - 1 Post Hex Nut Retainer

1x - 8-32 x 1.5 in Screw

39

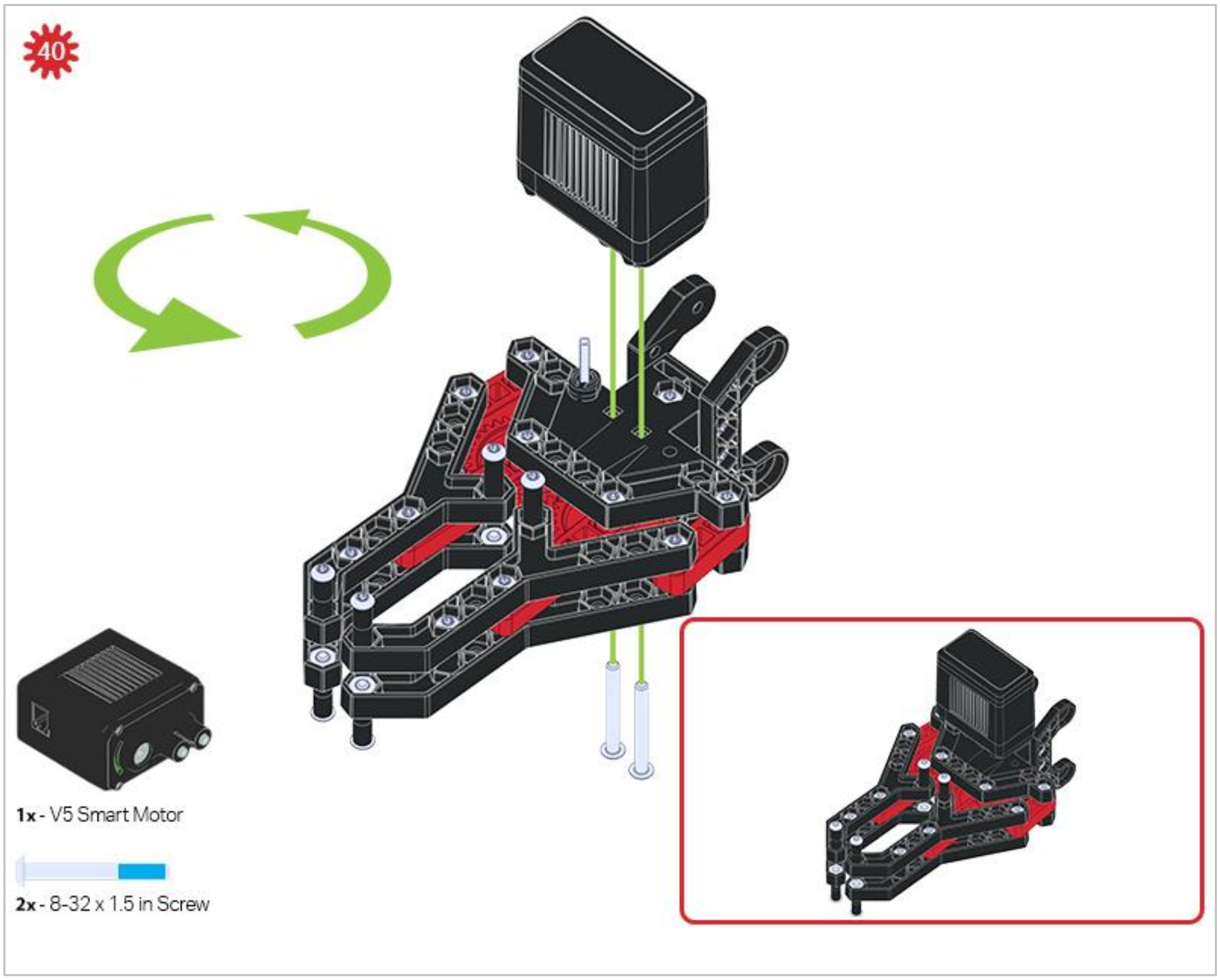


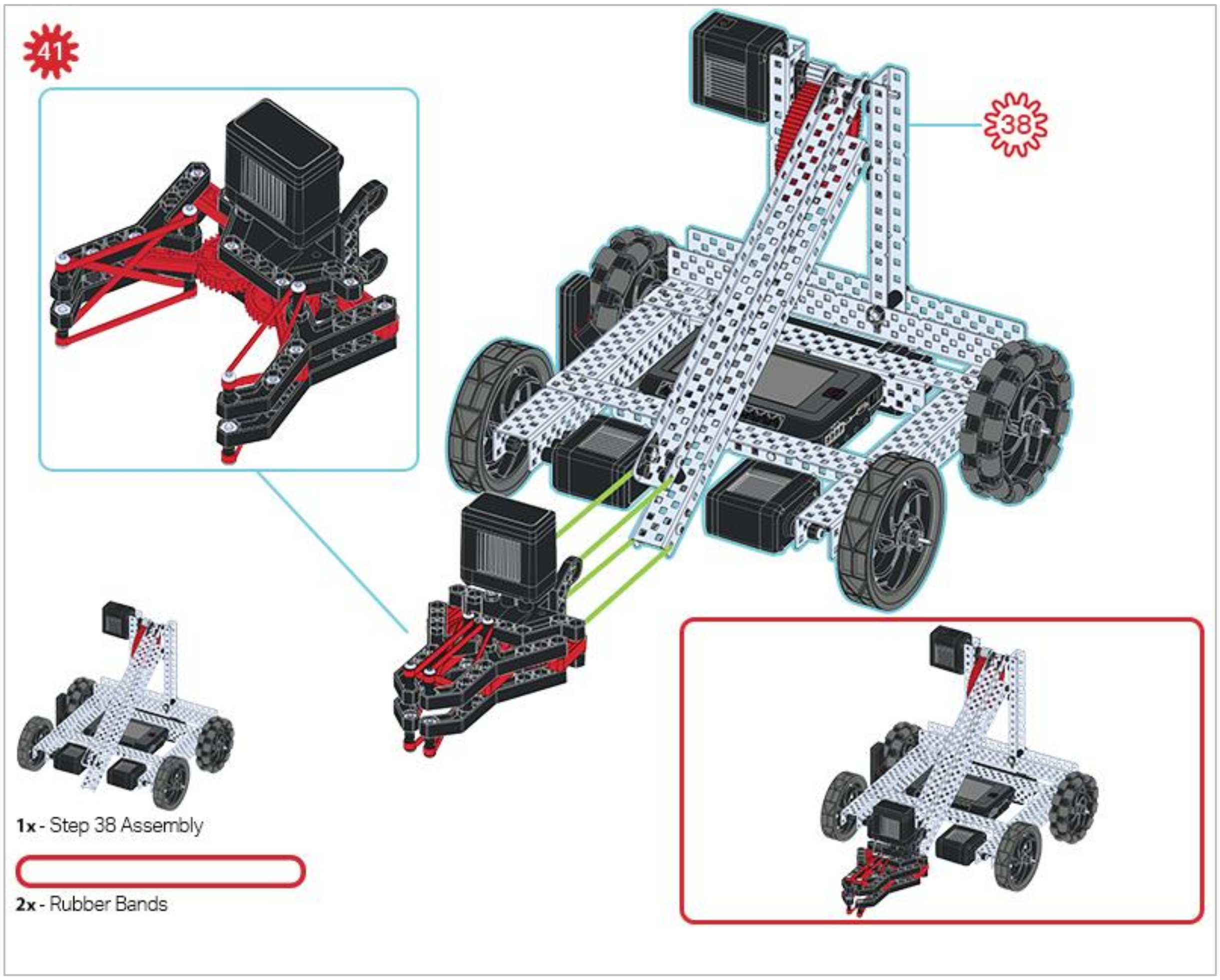
1x - Rubber Shaft Collar

1x - 12 Tooth Gear

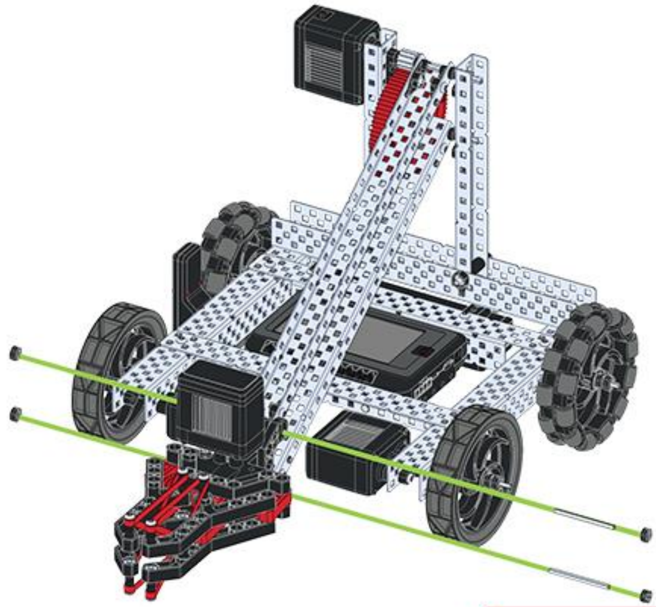
1x - 1x Claw Assembly

1x - 2 in Shaft


40
1x - V5 Smart Motor
2x - 8-32 x 1.5 in Screw

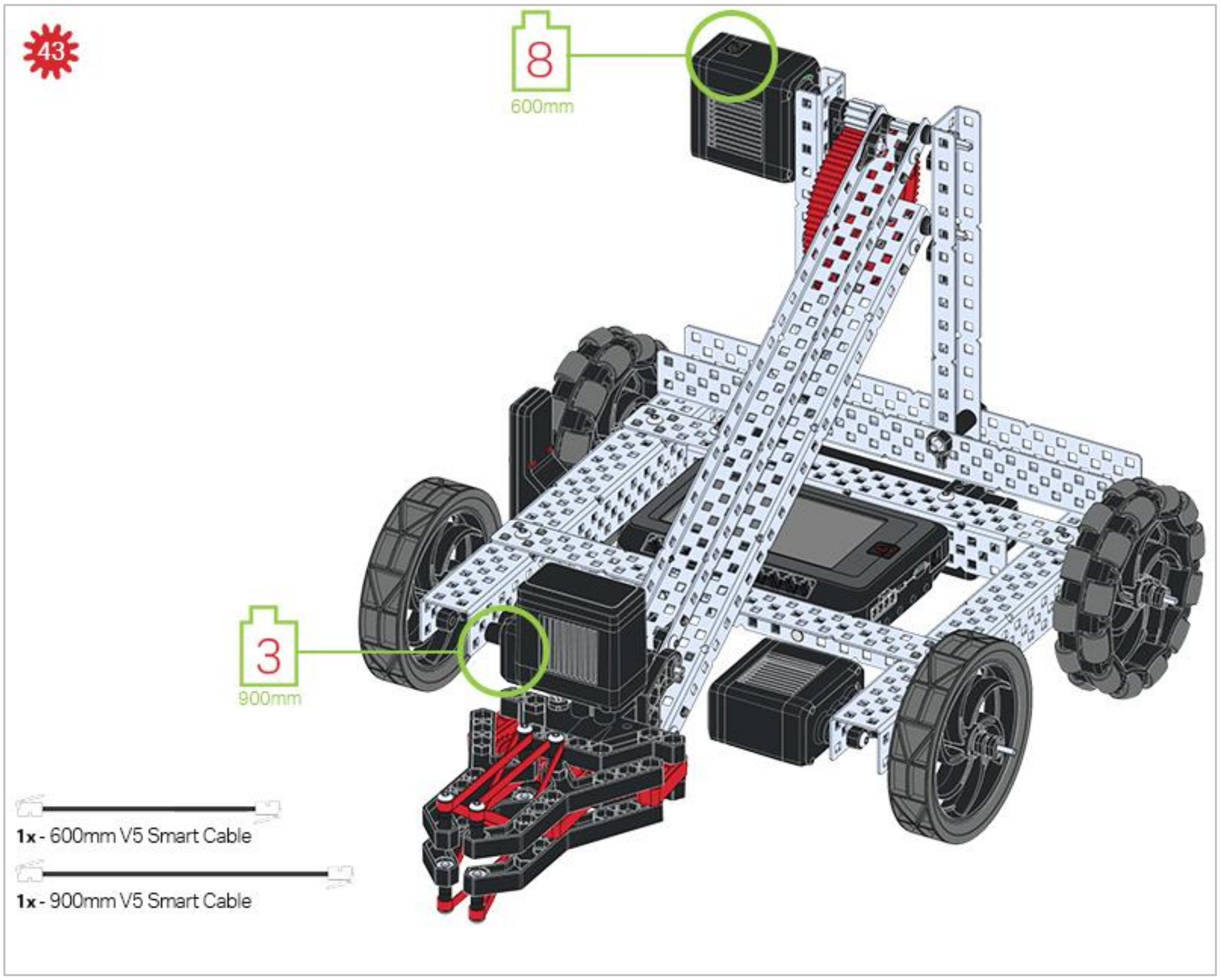

41
38
1x - Step 38 Assembly
2x - Rubber Bands

42



4x - Rubber Shaft Collar

2x - 2 in Shaft



Build Instruction Tips

Check the Appendix for info on how to use the new Hex Nut Retainers.

Step 4: The green icon indicates that the build needs to be flipped over (upside down).

- Step 6: Only one of the two sub-assemblies made in this step is used right now. The other will be used later in step 9.
- Step 7: Make sure your Smart Motors are oriented in the correct direction (screw holes facing the outside of the build and the shaft hole towards the inside).
- Step 10: Make sure your Smart Motors are oriented in the correct direction (screw holes facing the outside of the build and the shaft hole towards the inside).
- Step 18: The green icon indicates that the build needs to be rotated (180 degrees).
- Step 20: The blue call out shows what the orientation of the Robot Brain should be if the build were flipped right side up. Make sure the 3 wire ports on the Robot Brain are facing the V5 Radio!

- Step 22: The green call outs indicate which port on the Robot Brain to plug each device into using their respective cable.
- Step 29: Be sure to make two assemblies in this step!
- Step 30: This step adds onto the two assemblies started in Step 29.
- Step 31: Make sure to add this to only one of the two sub-assemblies you just made.
- Step 39: Make sure the 12- tooth gear is installed on the right side of the claw.
- Step 41: Make sure that the port on the Smart Motor is facing the right side of the robot when the claw is installed (the same side as the V5 Radio).

Exploration

Now that you've finished the build, test what it does. Explore your build and then answer these questions in your engineering notebook.

Notice how the front wheels of the Clawbot are powered by motors. Think about the weight distribution on the Clawbot.

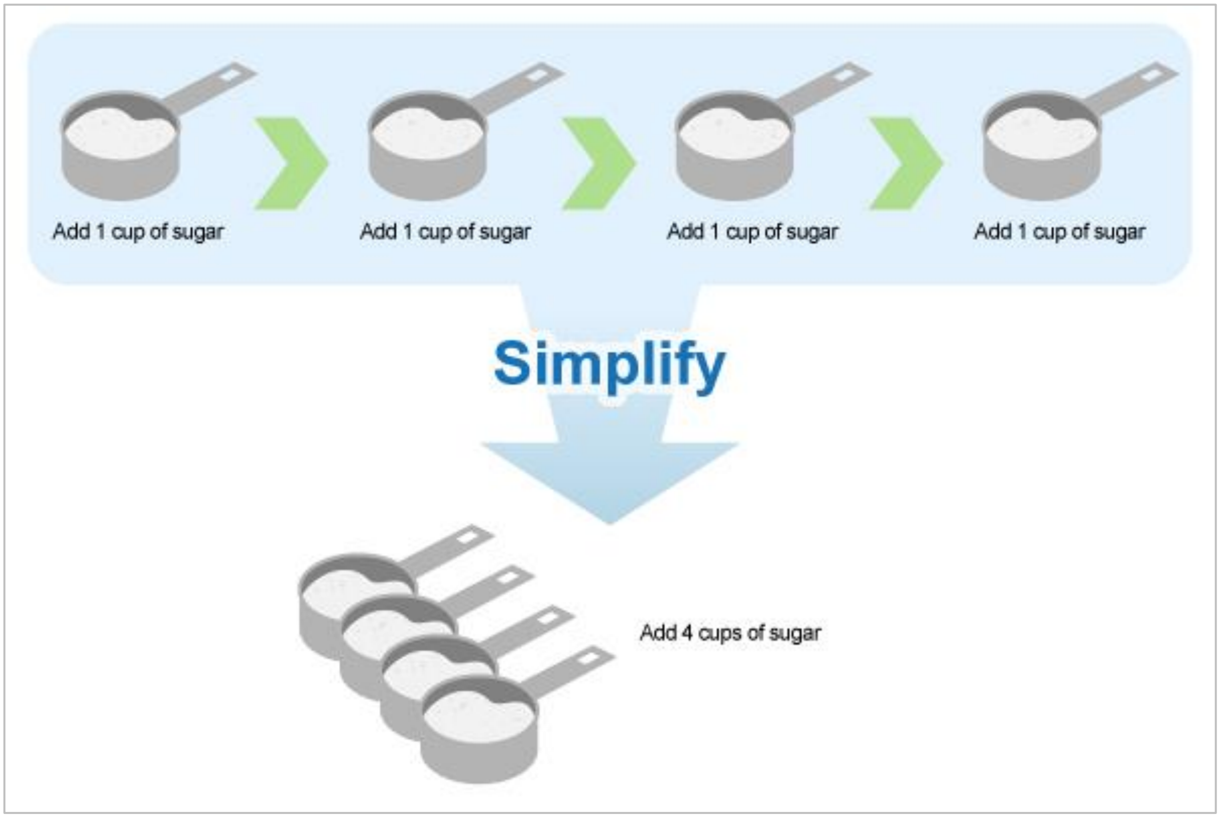
What if the velocity of the Left and Right motors were increased and the robot was being controlled using a Controller?

- If the robot was asked to drive in reverse quickly, what could possibly happen and why? Think about where the weight of the arm, claw, battery and Brain are on the robot.

SPARK
PLAY

Test your build, observe how it functions,
and fuel your logic and reasoning skills
through imaginative, creative play.

Loops: Simplifying Repetitive Action



Simplify Projects with Loops

We, as humans, repeat many behaviors in our daily lives. From eating and sleeping to brushing our teeth and walking our dogs, much of what we do each day is repetitive. In math class, we know that multiplying a number by zero, will always equal zero, or that multiplying a number by one will always equal itself, no matter how many times we do it. While we have a tendency to repeat our behaviors, our instructions can sometimes be simplified. For example, if you're using a recipe to bake a cake, it wouldn't tell you to "add 1 cup of sugar, add 1 cup of sugar, add 1 cup of sugar, add 1 cup of sugar." Instead, it would simply tell you to add four cups of sugar and you would scoop out 1 cup of sugar four times.

With robots, Loops help us simplify our projects. Instead of adding the same block four times, for example, we can use a Loop to tell the robot to perform the same behavior four times, saving time and space as we build our projects. Imagine a task that a robot might perform that would require repetition to complete the task. Those behaviors, along with a Loop block from the Control block category, are what you would need to project to achieve the task.

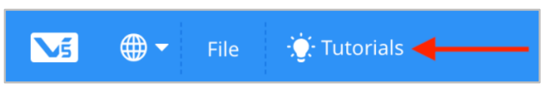
Controller: Tank Drive Exploration

Hardware/Software Required:

Quantity	Hardware/Other Items
1	VEX EDR V5 Classroom Starter Kit (with up-to-date firmware)
1	VEXcode V5 Blocks (latest version, Windows, MacOS, Chromebook)
1	Engineering Notebook
1	Using Loops (Tutorial)
1	Tank Drive example project

This activity will give you the tools to program your Controller.

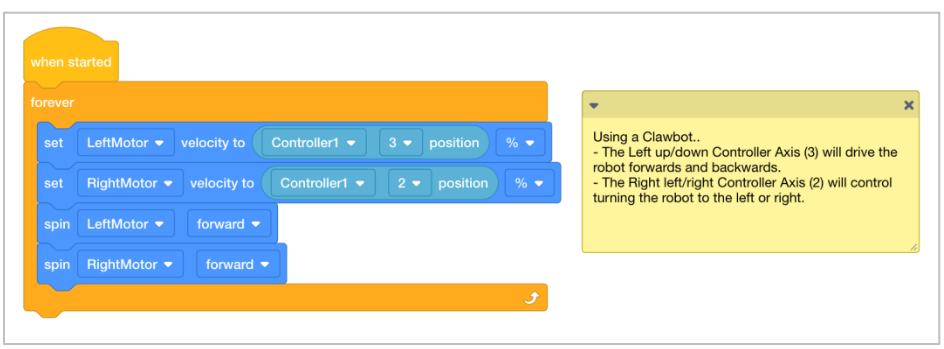
You can use the Help information inside of VEXcode V5 Blocks to learn about the blocks. For guidance in using the Help feature, see the Using Help tutorial.



1. Let's start programming the Controller.

Start by watching the **Using Loops** tutorial video.

- Open the Tank Drive example project.



Do the following in your engineering notebook:

Predict what the project will have the Clawbot do. Explain more than the fact that the project utilizes the Controller.
How do the joysticks move the robot? What is the Clawbot doing?

Save, download, and run the Tank Drive example project.

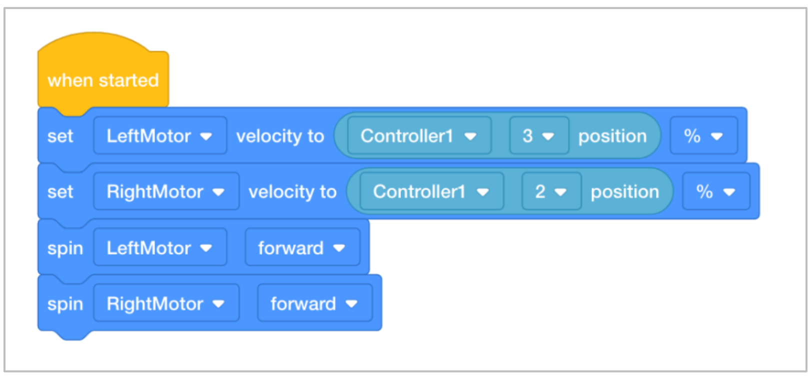
- For help, see the tutorial in VEXcode V5 Blocks that explains how to Download and Run a Project.

- Check your explanations of the project in your engineering notebook and add notes to correct them as needed.

2. Controller: Tank Drive

What are the benefits of using the forever block?

Here is our project without the forever block:



What do you think would happen if this program were run? Discuss as a group. Write down your prediction in the engineering notebook.

3. Navigate a Slalom Course!

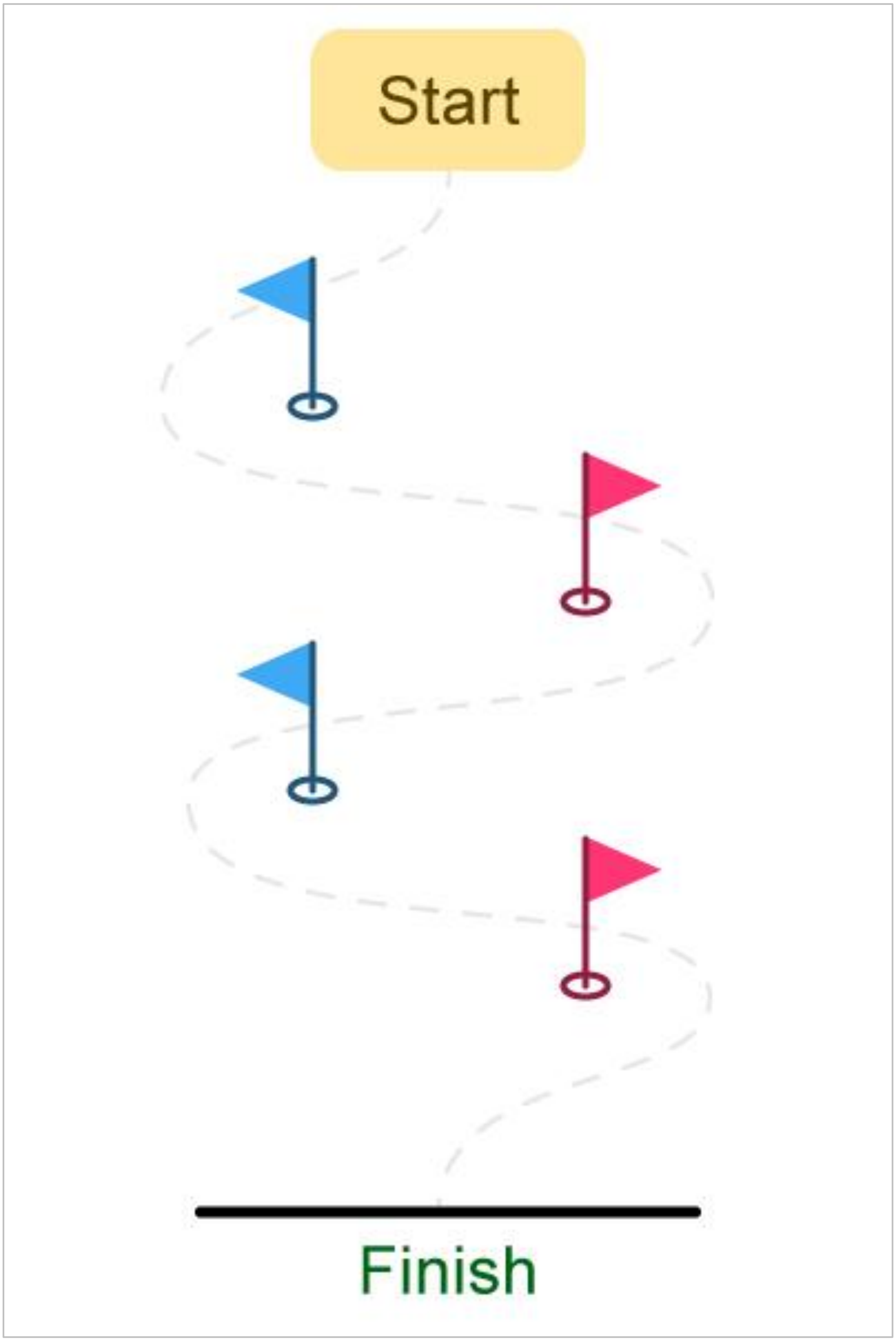
Slaloms are courses which the participant must navigate around the set flags, or markers. Ski slaloms are a popular winter sport and are included in the Winter Olympics.

Now that the Controller is paired and the project is downloaded, you are ready to move your Clawbot using the Controller!

Collect the four classroom items you will use as flags in your slalom from the teacher.

- Collaborate to set the flags in place for the Driver to navigate the Clawbot around, according to the slalom diagram.
- Download Tank Drive Example project. If there are any questions about how to download a project, check out the Download and Run a Project tutorial.

4. Robo-Slalom



Use the Controller to move your Clawbot along the outside of each "flag." The robot's path must prevent it from touching any flag, and allow it to cross the finish line.

Run the project and drive the Clawbot forward and reverse, and turn left and right using both Joysticks.

- Time how long it takes for the Clawbot to complete the course. Document the times in the engineering notebook.
- How fast can you get Clawbot through the Slalom course?

SPARK APPLY

Become a 21st century problem solver
by applying the core skills and concepts
you learned to other problems.

Using Loops to Make Candy

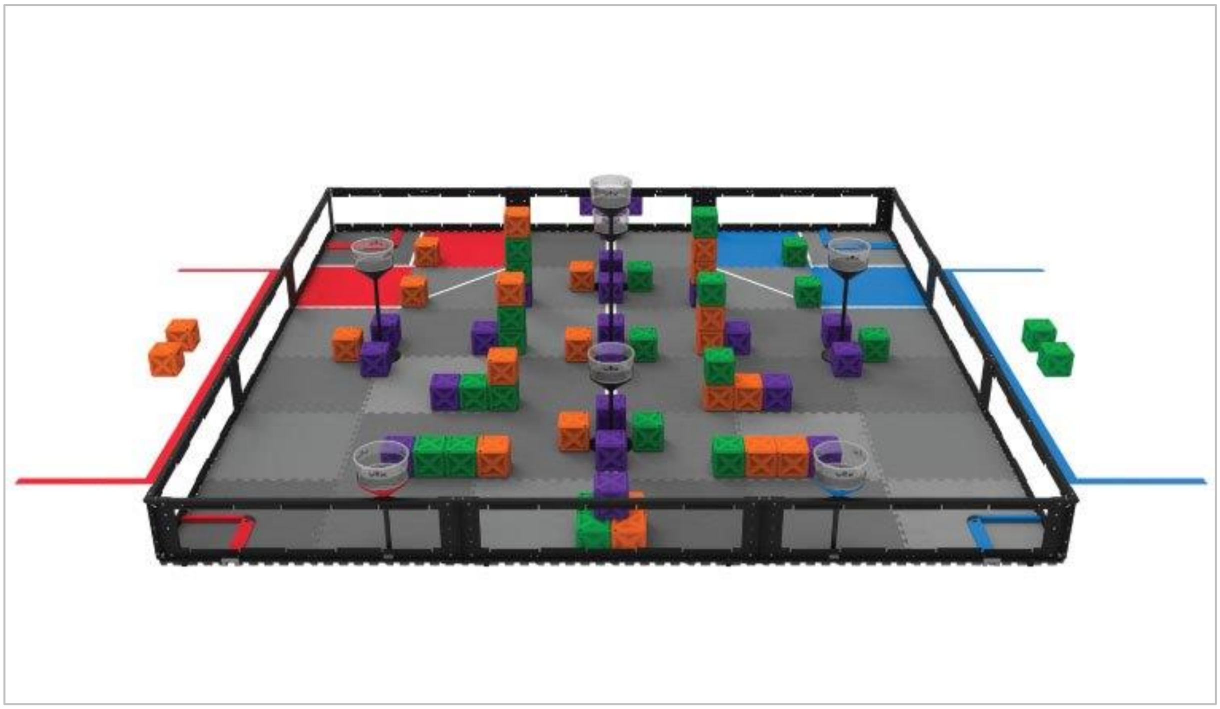
A conveyor belt moves chocolates along a mechanical assembly line.

Loops in Manufacturing

Robots are capable of doing the same task over and over by using loops. There are many advantages to having robots do repetitive tasks. Robots do not get tired, and do not need breaks (as long as they have constant power). For this reason, robots have become instrumental in manufacturing where robots can continuously do tasks which would be more difficult, or even dangerous, for humans.

An example of an industry which has benefited from robots doing repetitive tasks is the candy industry. Robots such as ABB’s Flexpicker can use a vacuum attachment to pick up hundreds of candies per minute. Robots can be programmed to exert the right amount of force for very delicate candies so they don’t get crushed. Robots on the assembly line can also use vision sensors to identify candies which are misshapen and not pick them up. Programming robots with loops can help make manufacturing, like the candy industry, more efficient.

Competition Connection: Driver Control



VRC 2019-2020 game - Tower Takeover field

Tower Takeover

Using loops to control the Clawbot with the Controller has allowed the driver to navigate the slalom course. Practicing driving the Clawbot is a useful task which can help you prepare for one of the challenges in the VEX Robotics World Championship.

The 2019-2020 VRC (VEX Robotics Competition) game is called Tower Takeover. In this game, the teams must have their robot pick up and move certain colored cubes into goals or towers. Teams will begin with a 15 second autonomous period where the robot cannot receive any help from the driver. In this period, the robot is being challenged to score on their own side of the field without any help from the driver.

After the autonomous period, the teams then engage in a 1 minute and 45 second driver-control period where the teams manipulate their robot using a controller. Teams attempt to score as many points as they can during this period.

Being able to use and program the controller is a large factor in performing well in competition.

SPARK
RETHINK

Is there a more efficient way to come to the same conclusion? Take what you've learned and try to improve it.

Event-Based Programming: Communication Among Blocks

Event-based programming

If your dog brings you his leash or sits by the door, he's letting you know that he needs to go outside. In school, when your teacher asks a question and sees you raise your hand, she knows that you believe you know the answer and would like to answer the question. These behaviors are also known as "triggers."

Your dog knows that bringing you his leash or sitting by the door is the trigger that lets you know he needs to go outside. So, when you see him sitting by the door with his leash, you react to the trigger by taking him outside. Raising your hand is the trigger that lets the teacher know you would like to answer her question. The teacher then reacts to the trigger by calling upon you.

Event-based programming in robotics is when certain robot behaviors trigger the robot to do certain things or react to certain triggers.

Controller: Clawbot Control

Now, you're ready to download the example project and use the Controller to operate the Clawbot, its Arm, and its Claw, all at the same time!

Ensure you have the hardware required and your engineering notebook. Open VEXcode V5 Blocks.

Hardware/Software Required:

Quantity	Hardware/Other Items
1	Clawbot
1	Charged Robot Battery
1	VEX V5 Radio
1	Controller
1	Tether Cable
1	VEXcode V5 Blocks
1	USB Cable (if using a computer)
1	Engineering Notebook

Before you begin the activity...

Do you have each of these items ready? The Builder should check each of the following:

Are all the motors and sensors plugged into the correct port?

- Are the smart cables fully inserted into all of the motors?
- Is the battery fully charged?
- Is the Controller paired with the Robot Brain?

Prepare for the Remix Challenges

Before you begin your project, select the correct example project. The Clawbot Control example project contains the Clawbot motors and sensors configuration. If the template is not used, your robot will not run the project correctly.

Go to the file menu, Open Examples, then select the Clawbot Control example project.

- **Save** the project.

- Check to make sure the project name Clawbot Control is now in the window in the center of the toolbar. The Clawbot is now properly configured, and the Clawbot Control project is ready for use.

Now, take a look at how the blocks are being used in this project. In your engineering notebooks, make the following predictions:

What's happening when you run this project? What will the Clawbot be able to do?

- What would happen if we didn't use the not block in this project?

Remix Challenges: Clawbot Control

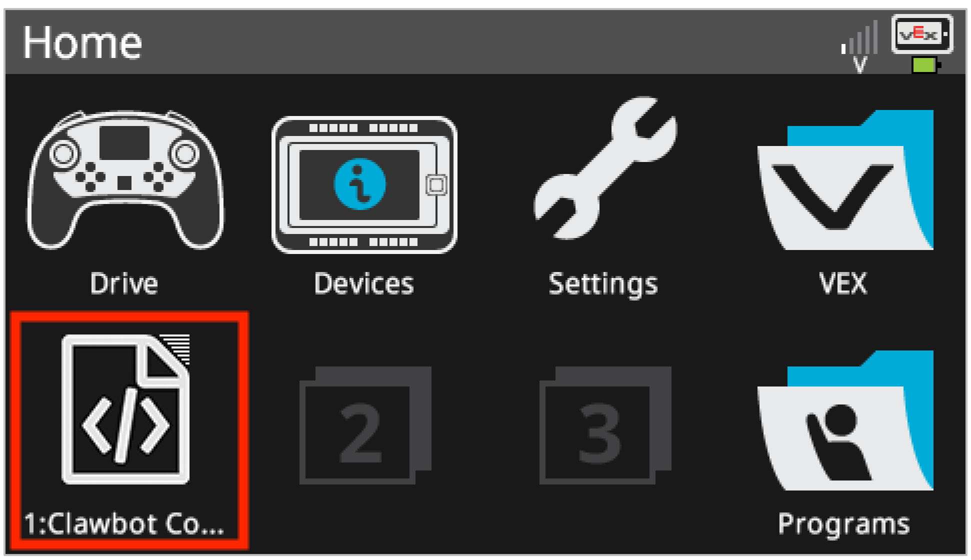
Grab an object!

The goal of this activity is to grab and release an object with the Clawbot using the Controller.

Here are some steps to guide your group:

Place your group’s object on the floor and make sure your Clawbot has enough space to move without interfering with other groups.

- List the steps the Clawbot will need to grab the object. Be sure to include which buttons you’ll use to accomplish this task!
- Write the steps the Driver lists in the engineering notebook.
- Click the Download button in the Toolbar to download the Clawbot Control project to the Robot Brain.



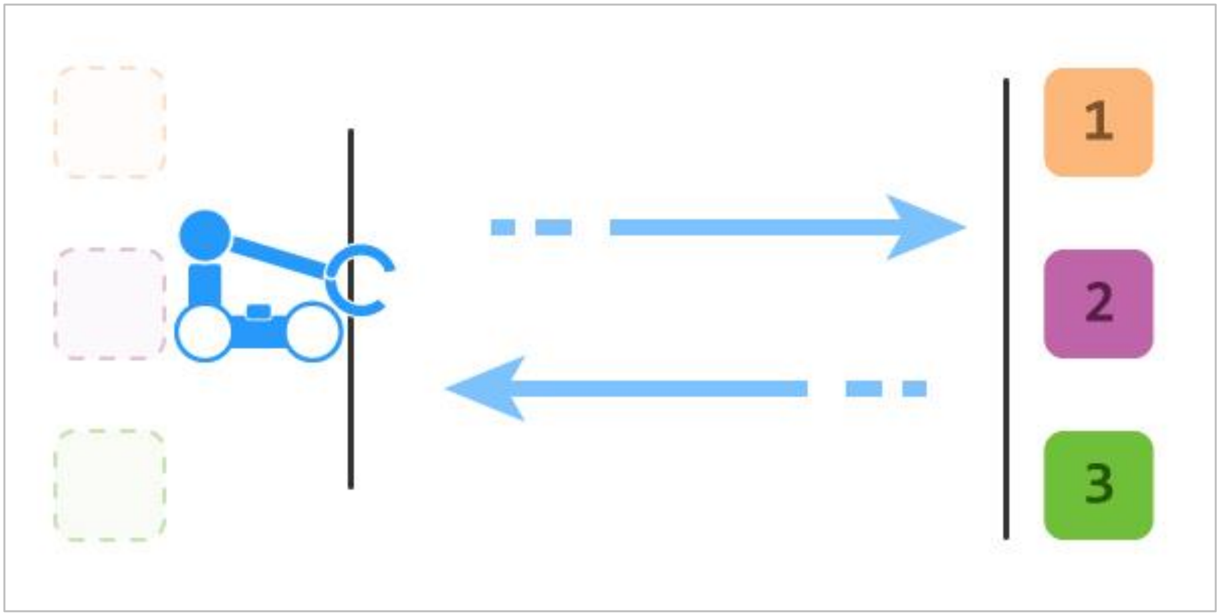
- Check to make sure your project has downloaded to the Clawbot’s Brain by looking at the Robot Brain’s screen. The project name, Clawbot Control, should be listed in slot 1.
- Run the project on the Clawbot.
- Grab and release an object with the Clawbot using the Controller.

Congratulations! You have grabbed an object with your Clawbot using the Controller!

Were there any differences between your predictions and the actions you to take during the activity? If so, add them to your engineering notebook.

Colored Gems

The goal of this activity is to use your Clawbot skills to collect several objects, one at a time, and return them to a location faster than the other groups in your class. Good luck!



Here are some steps to guide your team:

Move your group's objects behind the object retrieval area your teacher has established, and make sure your Clawbot has space to move without interfering with other groups.

- List the steps the Clawbot will need to grab each object and return them to home base. Be sure to include which buttons you'll use to accomplish this task!
- Write the steps the Driver lists in the engineering notebook.
- Using the classroom clock or a watch, keep time and record it in your engineering notebook.
- Retrieve each object as quickly as you can.

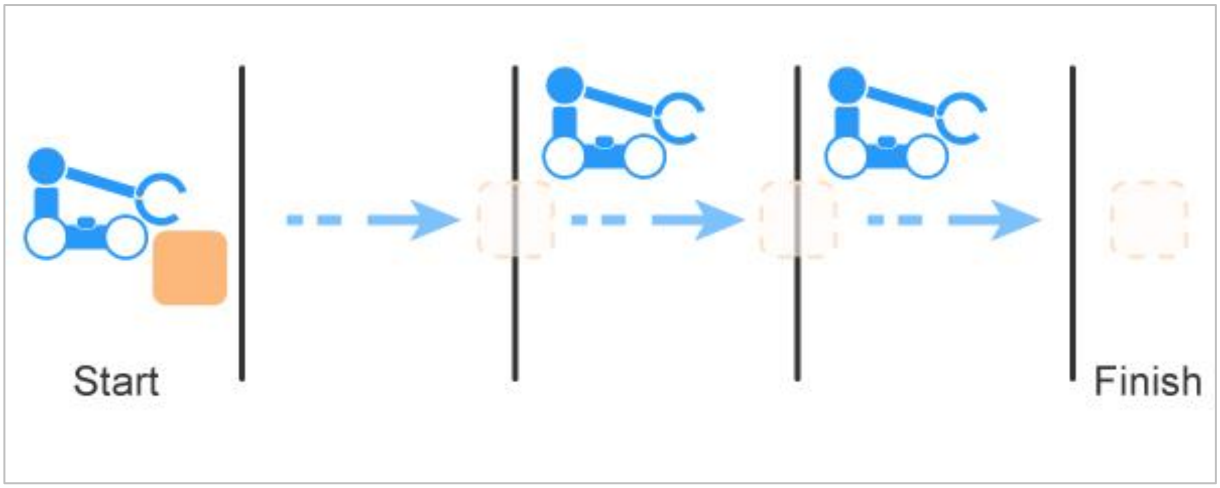
Congratulations! You have collected all three of your group's objects, returned them to home base with your Clawbot using the Controller!

Relay Race!

The goal of this activity is to use your Clawbot and teamwork skills in a relay race. The group will be responsible for moving an object across a three meter course in the fastest time possible.

Player 1: Pick the object and carry it to the one meter line. Drop the object.
Player 2: Pick up the object and carry from the one to the two meter line. Drop the object.
Player 3: Pick up the object and carry from the two meter line to the finish line. Drop the object in the goal area.

Player 4: Monitor the time and ensure the Clawbot does not obstruct any other drivers or students. Ensure the robot places the object far enough over the line.



Remix Questions

Answer the following questions in your engineering notebook after completing the three activities.

The set motor stopping block is set to “hold” for both the Arm Motor and the Claw Motor. What would happen if those blocks were removed?

- The spin and stop blocks that control the Arm and Claw Motors are nearly identical. If you were to create this project yourself, how could you save time and avoid dragging every individual block into the workspace over and over?

SPARK
KNOW

Understand the core concepts and how to apply them to different situations. This review process will fuel motivation to learn.

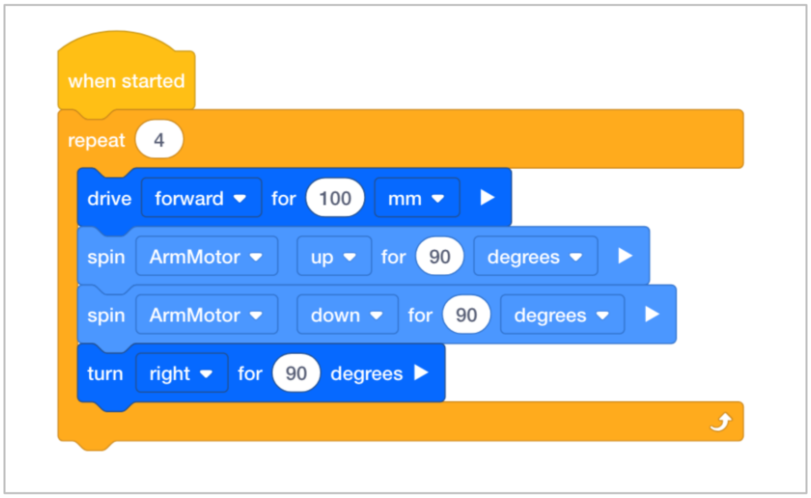
Review

You have accomplished a lot in this STEM Lab! The following questions will help you think back over everything you have learned. You can only answer once, so think carefully before you submit!

1. **Which of the following is true about the `forever` block?**
    - It will repeat a robot's actions forever.
    - It will repeat a robot's actions a set number of times.
    - It will stop after a certain amount of time has passed.
    - It can only be used when programming the Controller.

2. **Mitchel wants to program his Clawbot to continuously run in a square path around the room without stopping. Which is the best block to use to accomplish this?**
    - The wait until block
    - The repeat block
    - The forever block
    - The repeat until block

3. **Amy has created a project to make her Clawbot drive forward, raise and then lower the arm, and then turn right. She wants to repeat this series of behaviors 4 times. How many total mm has the Clawbot traveled when the loop is complete?**



- 104
- 100
- 400
- 90

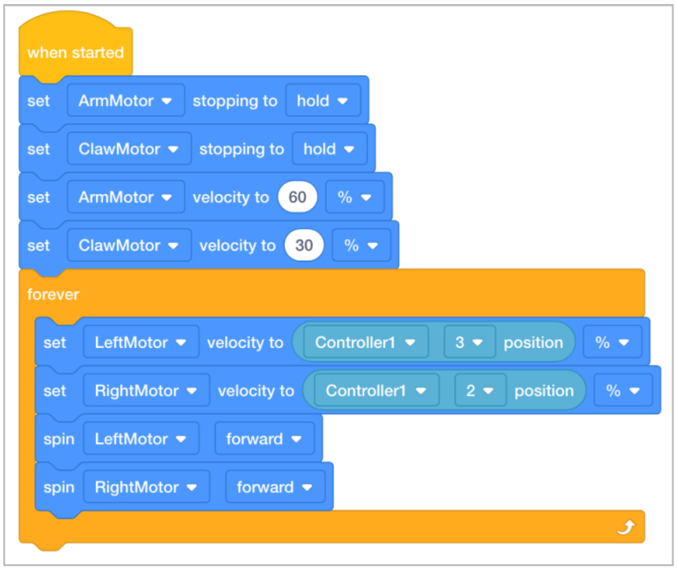
4. **Terrance is using a repeat block with 4 blocks inside of it. The repeat block is set to repeat 11 times. What is the right mathematical notation which describes how many total blocks the robot will run through in the project, including the repeat block?**

   - 1 + (4 x 11)
   - 4 x 11
   - 4 + 11
   - 1 + 4 + 11

5. **Which of the following words best completes the following sentence: The Joystick, L buttons, and R buttons are all _________ for event-driven programming in the Clawbot Control example project.**

   - Triggers
   - Comments
   - Loops
   - Stacks

6. **In the following project, what function does the set motor stopping blocks do?**



- They stop the motors from moving after the loop has ended.
- They do not allow Controller to move the Arm and Claw.
- They allow the motors to spin freely.
- They prevent the Arm from dropping and/or the Claw from closing when the buttons that control their motors are released.

APPENDIX

Additional information, resources, and materials.

Help Scout Articles

Links to Help Scout Articles for this STEM Lab:

How to Turn On/Off a VEX IQ Robot Brain
https://help.vex.com/article/243-how-to-turn-on-off-a-vex-iq-robot-brain

- How to Read Indicator Lights on the VEX IQ Robot Brain
  https://help.vex.com/article/251-how-to-read-indicator-lights-on-the-vex-iq-robot-brain
- How to Navigate the VEX IQ Robot Brain
  https://help.vex.com/article/244-how-to-navigate-the-vex-iq-robot-brain
- How to Connect VEX IQ Devices to Smart Ports
  https://help.vex.com/article/256-how-to-connect-vex-iq-devices-to-smart-ports
- How to Install or Remove the VEX IQ Robot Battery
  https://help.vex.com/article/260-how-to-install-or-remove-the-vex-iq-robot-battery
- How to Charge the VEX IQ Robot Battery
  https://help.vex.com/article/265-how-to-charge-the-vex-iq-robot-battery
- How to Use the Autopilot Program in the Demos Folder
  https://help.vex.com/article/274-how-to-use-the-autopilot-program-in-the-demos-folder
- Best Practices for Preserving the VEX IQ Robot Battery's Life
  https://help.vex.com/article/262-best-practices-for-preserving-the-vex-iq-robot-battery-s-life
- Ideas for Organizing the VEX IQ Super Kit
  https://help.vex.com/article/263-ideas-for-organizing-the-vex-iq-super-kit
- VEX IQ Brain Status (USB Cable)
  https://help.vex.com/article/291-vex-iq-brain-status-usb-cable

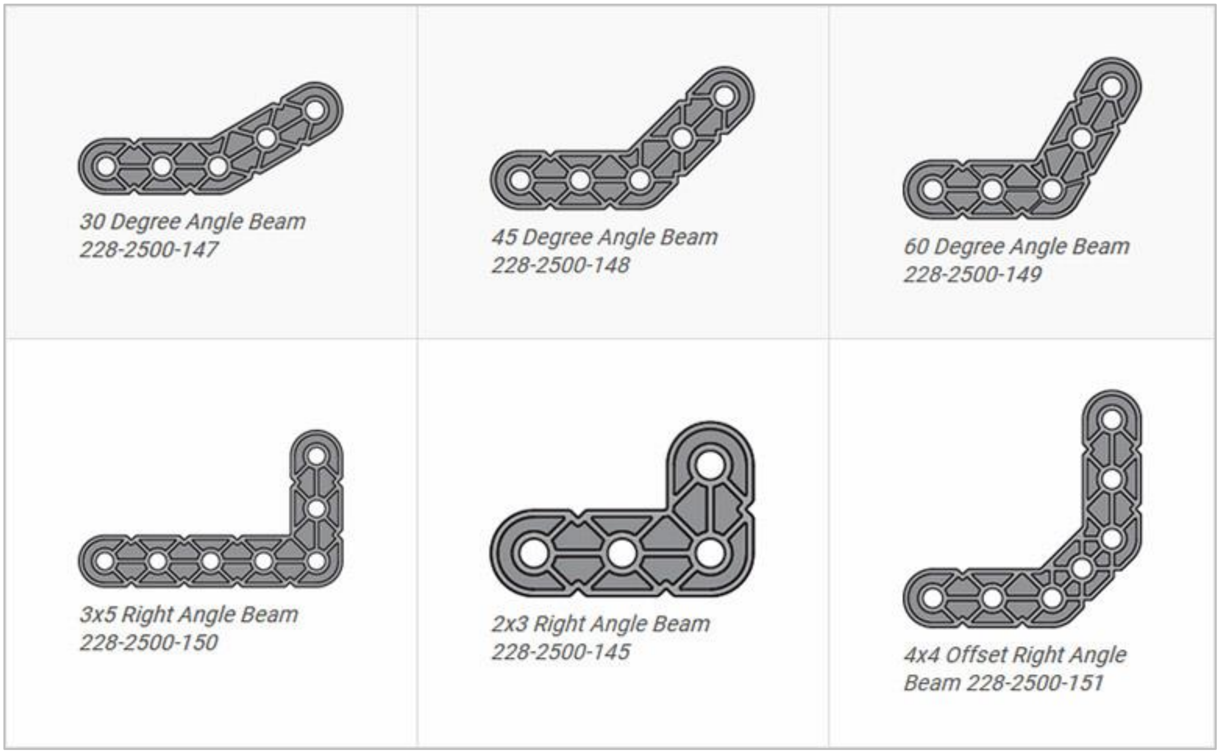
Links to VEXCode IQ Blocks Help Scout Articles for this STEM Lab:

How to Begin a New Project in VEXcode IQ Blocks
https://help.vex.com/article/279-how-to-begin-a-new-project-in-vexcode-iq-blocks

- How to Download and Run a Project
  https://help.vex.com/article/278-how-to-download-and-run-a-project
- How to Save a Project on Windows
  https://help.vex.com/article/287-how-to-save-a-project-on-windows
- How to Save a Project on MacOS
  https://help.vex.com/article/280-how-to-save-a-project-on-macos
- How to Save a Project on Chromebook
  https://help.vex.com/article/286-how-to-save-a-project-on-chromebook

- How to Download to a Selected Slot on the Brain
  https://help.vex.com/article/284-how-to-download-to-a-selected-slot-on-the-brain

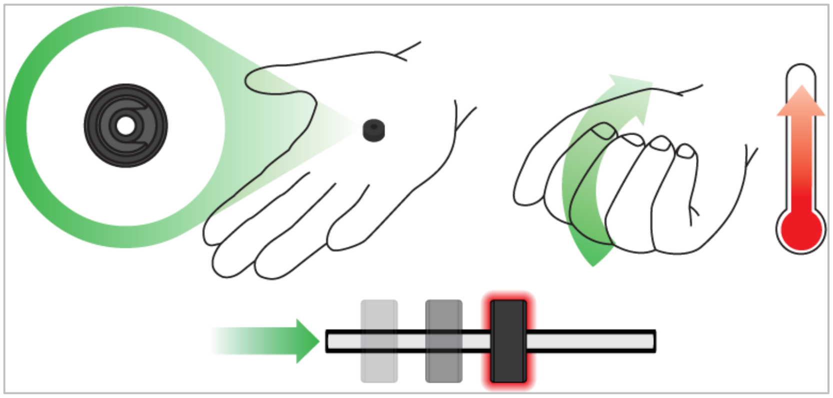
Identifying Angle Beams



How to Identify the Different Angles of the Angled Beams

There are four different types of beams that have a bend at an angle: 30^o Angle Beams, 45^o Angle Beams, 60^o Angle Beams, and Right Angle (90^o) Beams. There are also three types of Right Angle Beams: 3x5, 2x3, and Offset. The best way to tell which angles are which is to stack the beams on top of each other. Then you can compare how they look. You can also use a protractor to measure the angle of the beam.

Installing Rubber Shaft Collars

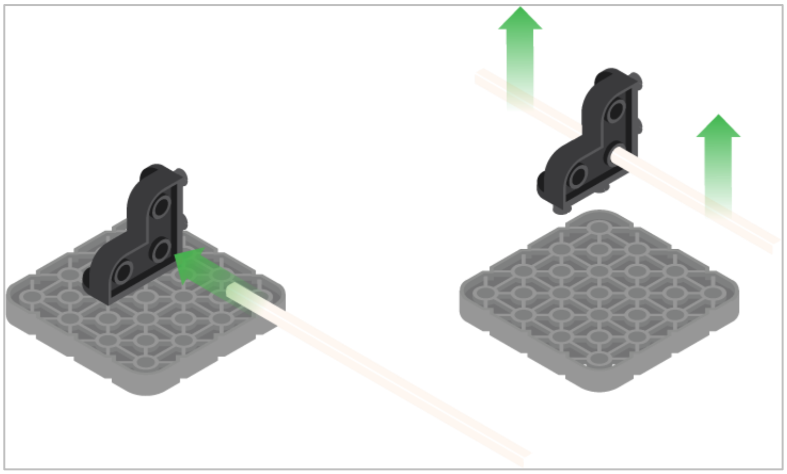


Using your hand to warm a Rubber Shaft Collar

Rubber Softens as it gets Warm

Hold the Rubber Shaft Collars in your hand for 15-30 seconds before you slide them onto a shaft. Holding the Rubber Shaft Collar in your hand will warm and soften the rubber to make it easier to slide onto a shaft.

Removing Connectors from Beams and Plates

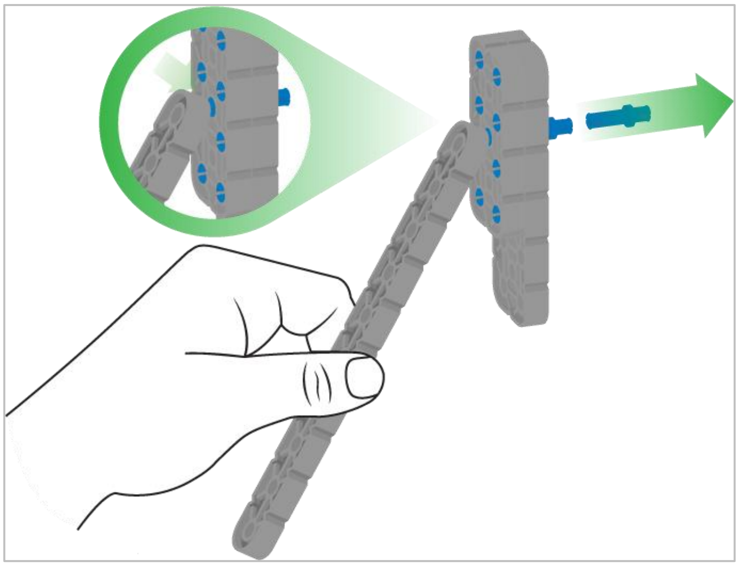


Using a pitch shaft to remove a corner connector

How to Easily Remove Connectors

You can easily remove corner connectors from beams or plates by placing a metal shaft through one of the holes of the corner connector and pulling outward while holding down the beam or plate.

Removing Pins from VEX IQ Beams and Plates



Removing a pin from a plate assembly using a beam

How to Easily Remove Pins from Beams and Plates

You can quickly remove connector pins from beams or plates by pressing a beam against the back of the pin, which partially pushes the pin out, so you can remove it with your fingers. You can use this technique to more easily remove pins from individual plates and beams, or from built structures.

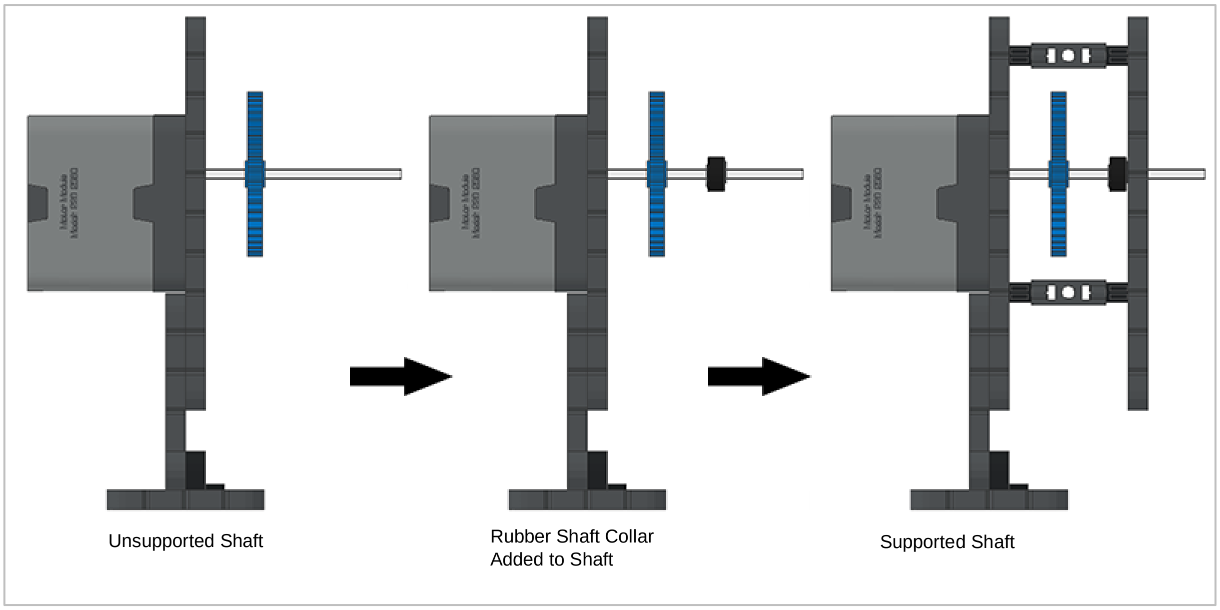
Removing Standoffs from Mini Standoff Connectors

Removal of a standoff from a Mini Standoff Connector

How to Easily Remove Parts from Mini Standoff Connectors

Standoffs and Mini Standoff Connectors can be separated by pushing a shaft through the Mini Standoff Connector. The same technique can be used for parts with similar ends in Mini Standoff Connectors, such as pins.

Supporting Shafts using Rubber Shaft Collars

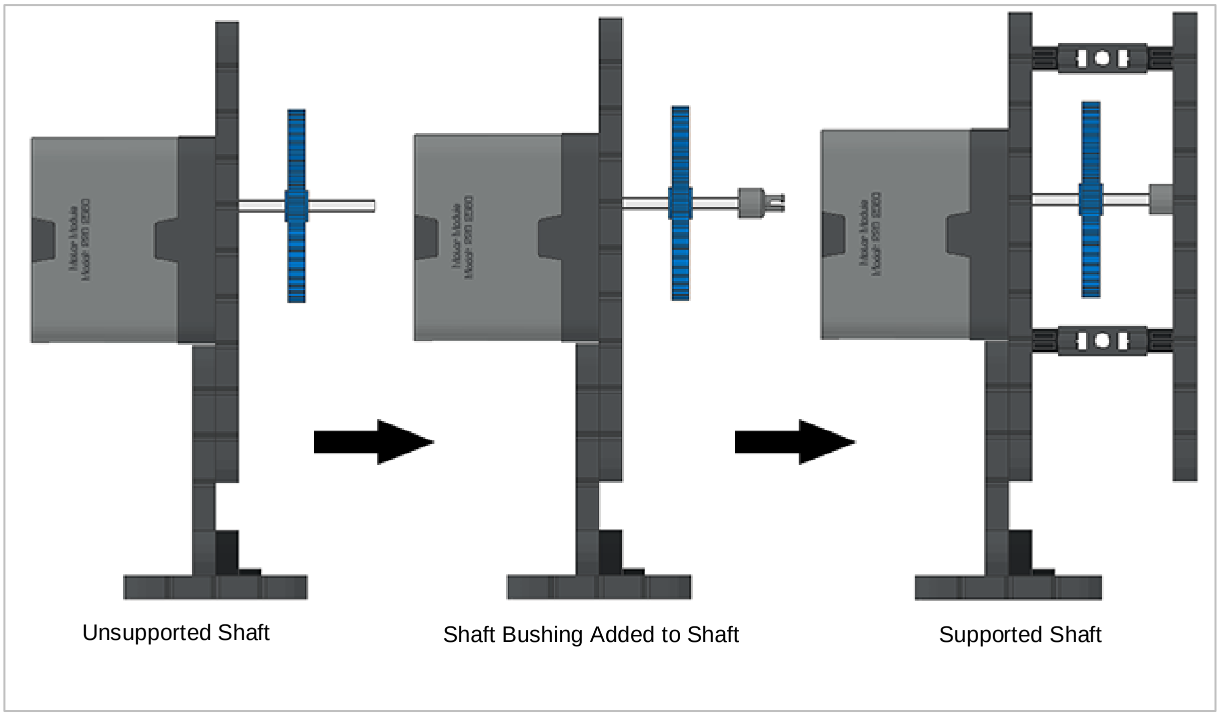


Supporting a shaft with a Rubber Shaft Collar

How to Support Shafts with Rubber Shaft Collars

Shafts can fall out of place or alignment very easily if they aren't supported properly. You can make a shaft more secure and prevent it from falling out of place by putting a Rubber Shaft Collar before the end of it. You can then connect the shaft to a support structure with the shaft collar positioned against it. That will allow the shaft to turn but will prevent it from wobbling or falling out.

Supporting Shafts using Shaft Bushings



Supporting a shaft with a Shaft Bushing

How to Support Shafts Using Shaft Bushings

Shafts can fall out of place or alignment very easily if they aren't supported properly. You can make a shaft more secure and prevent it from falling out of place by putting a bushing at the end of it. You can then connect that bushing into another beam or additional part. That will allow the shaft to turn but will prevent it from wobbling or falling out.

Popups within this STEM Lab

Stop and Discuss — Driving Forward and Reverse Exploration

These steps are very important because they will begin almost all programming explorations. For example you can say, “Let’s pause here for a moment. As a group summarize the steps we just completed. Record your summary in your engineering notebook.”

Remind the students that each group should have someone in the Recorder role. Allow students approximately 5 - 10 minutes to summarize the steps. If time allows, ask each group to share their summary. An example of what the summary could look like:

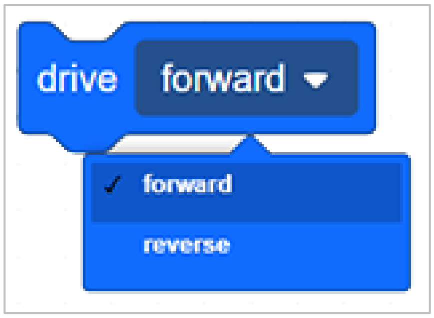
Open the file menu

- Select examples
- Choose a template
- Name the project
- Save the project

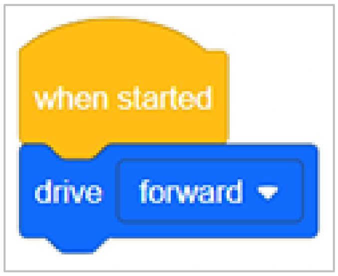
Program Autopilot to Move Forward

The drive block can be used to drive a robot forward or backwards.

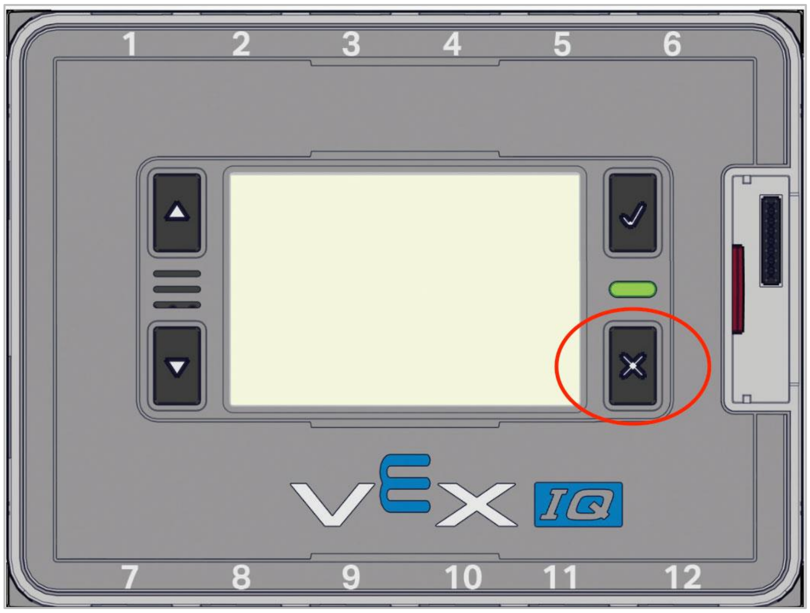
In order to move the Autopilot in reverse, the student will just need to change the drive block to “reverse.” Anything editable inside of the blocks is called a parameter.



When using the drive block, it is important to note that block used by itself does not cause the robot to stop moving. For example, if the project below was downloaded and run on a robot, the robot would drive forward without stopping.



In order to get Autopilot to stop moving, the X would need to be pressed on Autopilot’s Robot Brain. Pressing the X button on the Robot Brain ends the project and stops all of the motors.



In the Forward and Reverse exploration, the students will just use the drive block. However, other blocks can be used to program basic movements.

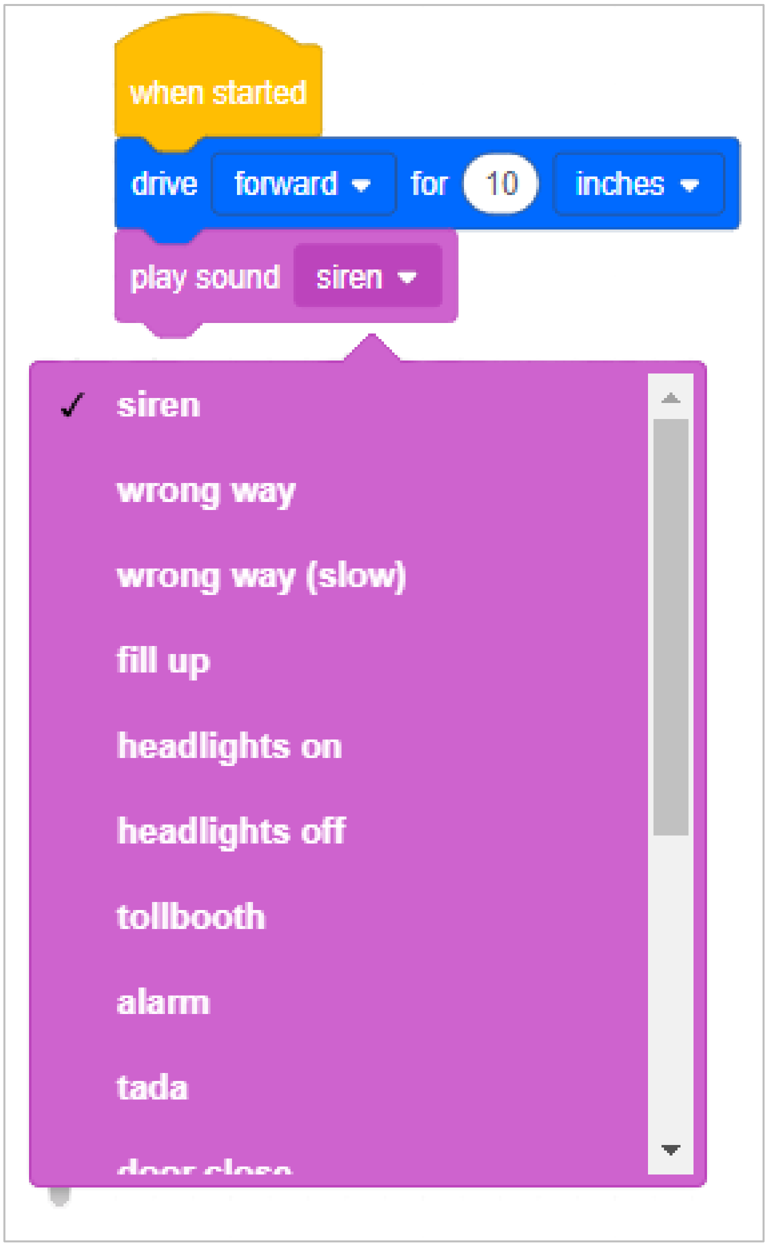
If the student wants to move a specific distance, they can use the drive for block.

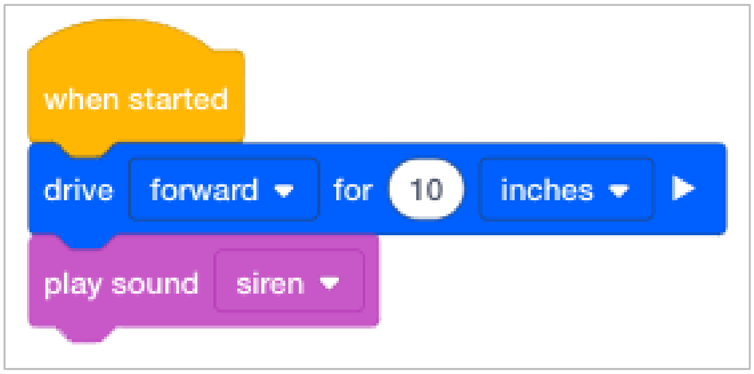
Students can change the distance traveled by adjusting the parameter in the block.

In the project above, the distance was changed from 1 inch to 30 inches. Students can program their robot to move in mm or inches.

play sound Block

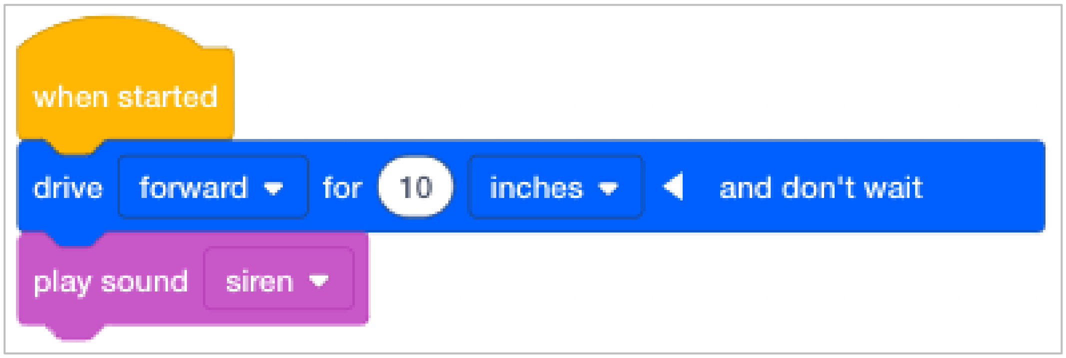
Students will be adding a play sound block to their program.





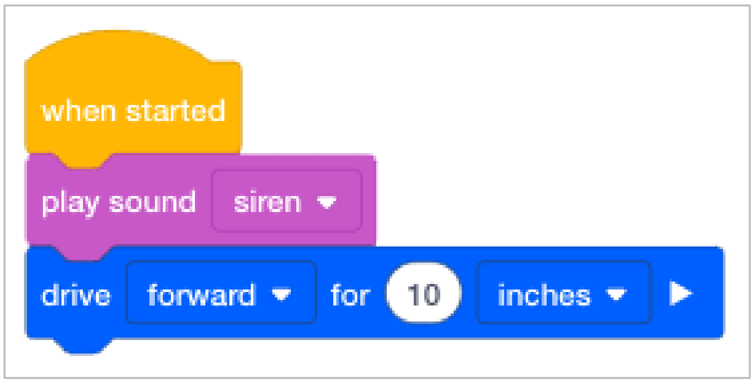
With this example, the robot will drive forward for 10 inches and then play the siren sound. The drive for block in this project is a waiting block. This means that the block will pause the rest of the stack until it has been completed. Therefore, the Autopilot will drive forward for 10 inches and then make the siren sound.

The drive for block can be expanded to become a non-waiting block, as in the example below.



With this program, as soon as Autopilot starts driving, it will immediately play the siren sound. This is because the drive for block is now set to non-waiting. It is NOT going to pause the stack until it has been completed. Some of the blocks in VEXcode IQ Blocks can be changed from waiting to non-waiting by selecting the arrow at the end of the block.

The play sound block is also a non-waiting block. Therefore, when the project below is run, Autopilot will play the siren and immediately begin to drive forward.



Organizing Students into Groups for Exploration

Organize the students into groups before beginning the exploration. Students can be organized into groups of two to four students when participating in the exploration. The following roles can be utilized during the exploration:

Builder — This person checks that the robot is properly built and ready (e.g., Are all the motors and sensors plugged into the correct ports? Is the Robot Brain turned on?) before a project is run.

- **Programmer** — This person will use the drive block to create a project on the computer or tablet. This person will also download the project to the robot.
- **Driver** — This person selects the project and then runs it on the robot. This person will also be the one to retrieve the robot after it as run.
- **Recorder** — This person writes down all of the group answers/reflections in the engineering notebook.

If there are two students in each group, the students can each choose two roles. If there are three students in a group, one of the students can choose to do two roles. If there are four students in a group, each student can have one role.

Provide the list of roles and their definitions to the students. Once students are in their groups, allow the members to choose their role. Circulate the classroom and make sure that every student has a role. There is an optional collaboration rubric.

Remind the students of roles throughout the exploration. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else's role or not fulfilling their assigned role. Reminding students about who is supposed to be doing what can be a useful intervention.

Motivate Discussion — Driving Forward and Reverse Exploration

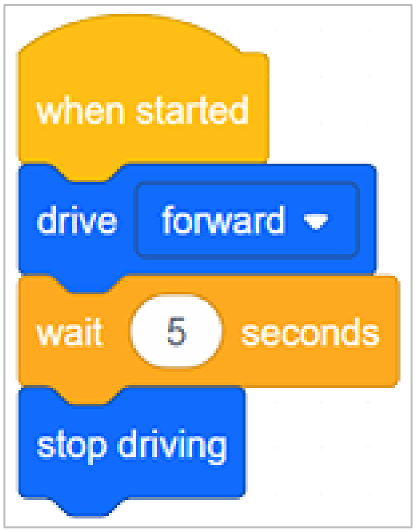
Motivate Discussion

Q: Ask the students what they think would happen if they added a stop driving block to their project. (Have them record their answers in their engineering notebooks).

A: With this project, the robot would not move at all. This is because the project is telling the robot to drive forward, but then it is immediately telling it to stop. This happens so quickly that the robot does not move.

If students did answer that Autopilot would move forward and then stop, the students could then be asked how far the robot would move forward before it stopped. This could lead into the discussion that the project moves very quickly through the commands and eventually lead the students to realize that because the project does move so quickly through the commands that the robot does not move.

The discussion could then be a good introduction to the use of the wait block:



By using the wait block, a student can program a robot to drive forward for a certain amount of time. For example, in the project below, a robot would drive forward for 5 seconds and then stop.

Exploration Roles

Students can be organized groups of two to four students when participating in the exploration.

The following roles can be utilized during the exploration:

Builder -- This person checks that the robot is properly built and ready (e.g. Are all the motors and sensors plugged into the correct port? Is the Robot Brain turned on?) before a project is run.

- **Programmer** -- This person will use the drive block to create a project on the computer or tablet. This person will also download the project to the robot.
- **Driver** -- This person selects the project and then runs it on the robot. This person will also be the one to retrieve the robot after it has run.
- **Recorder** -- This person writes down all of the group answers/reflections in the engineering notebook.

If there are two students in each group, the students can each choose two roles. If there are three students in a group, one of the students can choose to do two roles. If there are four students in a group, each student can have one role.

Provide the list of roles and their definitions to the students. Once students are in their groups, allow the members to choose their role. Circulate the classroom and makes sure that every student has a role. There is an optional collaboration rubric on this page.

Remind the students of roles throughout the exploration. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else’s role or not fulfilling their assigned role. Reminders about who is supposed to be doing what can be useful interventions.

Drive Forward and Reverse Exploration Outline

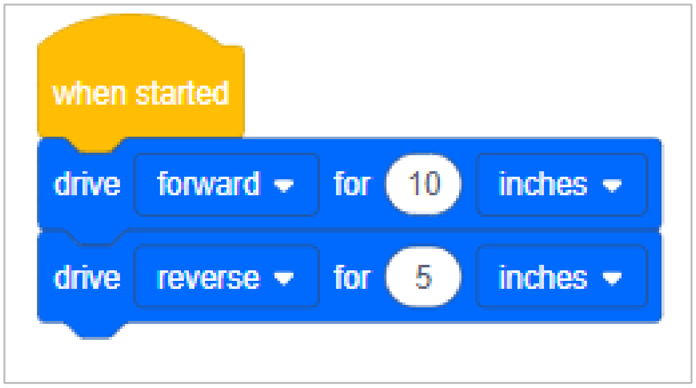
The outline for the Drive Forward and Reverse Exploration is as follows:

Introduce the drive block

- Do a quick troubleshooting check that the VEX IQ Autopilot is ready
- Start a new project in VEXcode IQ Blocks
- Rename and save the project
- Create the Drive project that moves Autopilot forward
- Download and run the project
- Change the Drive project to move Autopilot in reverse
- Download and run the project
- Wrap up the activity with a discussion

drive for Activity B Program Answers

Bonus:



Demonstrating how the Drivetrain to Drive Blocks are Related

Have an Autopilot robot to demonstrate for the students. Introduce to students the drive block. Read the description of the drive block in the Help. Either have VEXcode IQ Blocks displayed in front of the classroom, or have each student group follow along at their workstation. When discussing the descriptor and purpose of the block, ask the students if they can identify what a Drivetrain is. Discuss with the students that a Drivetrain consists of:

A rectangular Chassis (the structure of a mobile robot that holds wheels, motors, and/or any other hardware used to make up a Drivetrain)

- Two Motors
- Four Wheels
- Gears transmitting Power from the Motors to all Wheels

Use Autopilot robot to show the students the parts of the Drivetrain during the discussion. Next, gently turn one of the wheels that is connected to a motor. Show the students that because of the gears, even though the force is being applied to one wheel, both wheels are moving. Tell the students that instead of moving the wheels by hand, we'll use the drive block to program the motors to run and the wheels to turn.

Cultivating a Positive Learning Environment

Recognize and reinforce positive behaviors by creating a list of specific behaviors you want to encourage. Examples could include:

Students self-organizing with the roles within a group

- Students performing each of their roles well within a group
- Students handling the robot and the computers/tablets with care
- Students praising and encouraging one another during the exploration

When students use these behaviors, praise them immediately. Be specific when offering praise. For example, instead of saying, “good job,” you could instead say, “good job carefully returning the Autopilot robot to the correct spot.”

Configuration for Autopilot's Motors and Sensors

The configuration for Autopilot’s motors and sensors are:

Port 1: Left Motor

- Port 2: Distance Sensor
- Port 3: Color Sensor
- Port 4: Gyro Sensor
- Port 5: Touch LED
- Port 6: Right Motor
- Port 8: Bumper Switch
- Port 9: Bumper Switch

Building the Autopilot Robot with a Team

Teacher Toolbox

The build instructions will show students step-by-step instructions on how to build the Autopilot Robot. The Build Instruction Tips section will point out additional information for specific steps which will help students be successful with their build, so be sure to point out that section to students. There is an optional rubric to evaluate the robot build on this page. If any rubrics are used to evaluate students, review the rubric or pass out copies before students begin working so they are clear on how they will be assessed.

Before starting the build, consider how your students will be organized. Will each student have their own robot, or will they work in pairs or teams? If working in teams, each student could build a portion of steps or each student could be given a role. The following roles can be utilized during the building of Autopilot:

Right wheel — This person follows steps 1-6 to build the right wheel of Autopilot. This person is also responsible for making sure that the motor gets plugged into the correct port (port 6).

- **Left wheel** — This person follows steps 7-12 to build the left wheel of Autopilot. This person is also responsible for making sure that the motor gets plugged into the correct port (port 1).
- **Sensors** — This person follows steps 13-26 to build the frame and attach the sensors.
- **Robot Brain** — This person follows steps 27-30 to connect all of the components including the Robot Brain and making sure the sensors are attached to the correct ports. This person is also responsible for making sure that the battery is charged and ready.

  — Port 2: Distance Sensor

  — Port 3: Color Sensor

  — Port 4: Gyro Sensor

  — Port 5: Touch LED

  — Port 8: Bumper Switch

  — Port 9: Bumper Switch

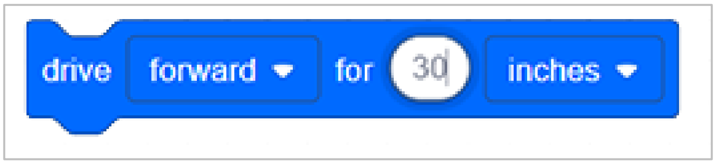
If there are two students in each group, the students can each choose two roles. If there are three students in a group, one of the students can choose to do two roles. If there are four students in a group, each student can have one role.

Provide the list of roles and their responsibilities to the students. Once students are in their groups, allow the members to choose their role. Circulate the classroom and make sure that every student has a role. There is an optional collaboration rubric on this page.

Remind the students of roles throughout the exploration. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else's role or not fulfilling their assigned role. Reminders about who is supposed to be doing what can be useful interventions.

Adjusting Parameters

Students can change the distance traveled by adjusting the parameter in the block.



In the program above, the distance was changed from 1 inch to 30 inches. Students can program their robot to move in mm or inches.

How is the drive for block able to program a robot to move to a precise distance? In the Robot Configuration, you are able to specify the size of the wheels. For example, the typical wheel size for the Autopilot is 200 millimeters. This is the default setting in the Robot Configuration.

However, what does wheel size actually mean? The listed wheel size is the actual wheel circumference. This means that every time the wheel completes one full rotation, it travels 200 millimeters. When the drive for block is programmed to move forward a specific amount of inches or millimeters, the programming logic inside of the drive for block performs math calculations. For example, if the drive for block is programmed to move forward 2000 millimeters, that means that the wheels have to travel 10 complete rotations. The drive for block is able to track each degree the wheel moves via the encoders that are found within the motor.

All of this math is completed with the programming logic built into the drive for block.