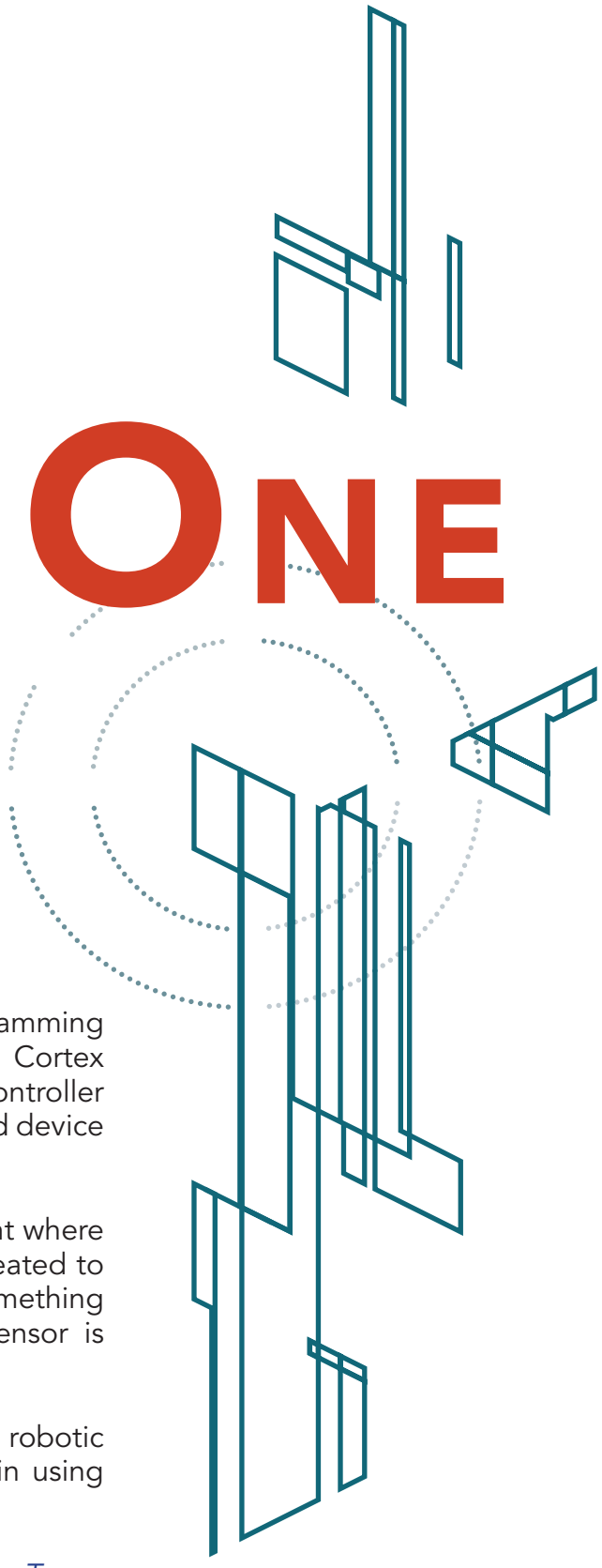
Level One

Programming For Robotics: DC Motors



In this level, students learn the basics of programming robots with The Brain robotic controller using the Cortex programming environment. The Brain is a micro-controller which is used to coordinate various sensor inputs and device outputs according to programs created for it.

The Cortex is a computer programming environment where a sequence of instructions or procedures can be created to instruct the micro-controller (The Brain) to do something (such as make a motor turn on when a touch sensor is activated).

Direct current (DC) motors are used to operate robotic devices. DC motors connect to ports on The Brain using **cables**.

Bolded *words are defined in the Concepts and Key Terms section at the end of each level.*

Level One Schedule

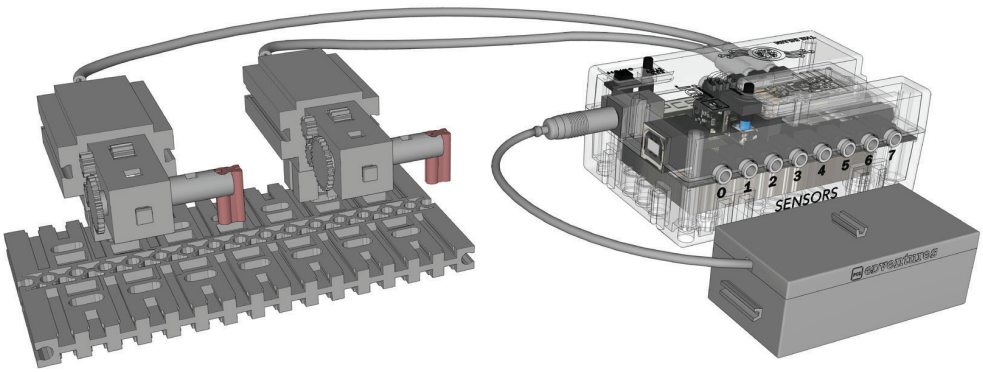
- Project 1: Build and Program a Motor Test Station
  - Connect It
- Challenge 1: Create 3 Programs
  - Reflect
- Project 2: This Way/That Way
- Challenge 2: This Way/That Way
  - Reflect
- Personal Project: Computational Multitasking
  - Reflect
- Key Concepts

Project 1

Build and Program a Motor Test Station

In this project, students build a DC motor testing station, connect everything properly, and identify all ports and **cables**. Also begin writing the first set of commands in Cortex.

Begin by building a testing station. When finished it should look like this:

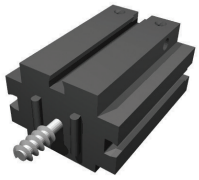


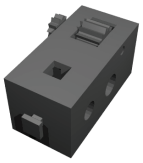
Icon Legend

- STOP — Set assembly aside.
- x2 — Build the number shown.
- Rotate assembly.
- Flip assembly.

Materials you will need:

*some part colors may vary


Mini Motor 6-9v
(Qty 2)


Motor Reducing
Gearbox
(Qty 2)

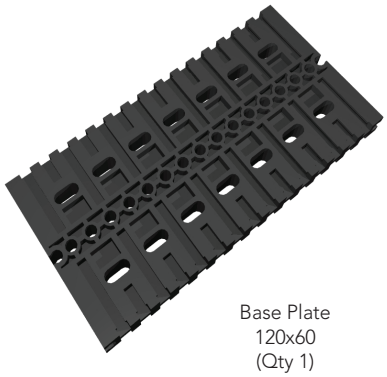

Link 15
(Qty 2)


Clip Adapter
(Qty2)

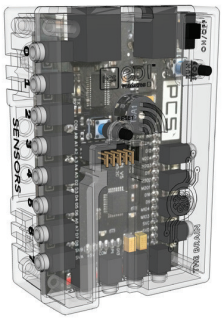

Building Block
15 with 2 Pins
(Qty 2)


Clip Axle T28
(Qty 2)


Motor Plug
(Qty 2)

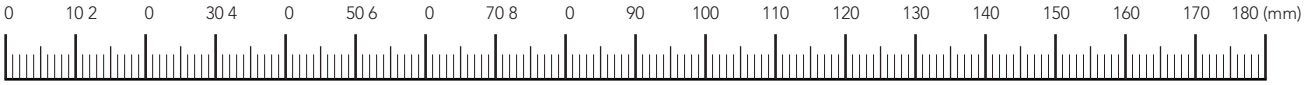

Base Plate
120x60
(Qty 1)


Battery with Cable
(Qty 1)



Brain
(Qty 1)


Dongle
(Qty 1)

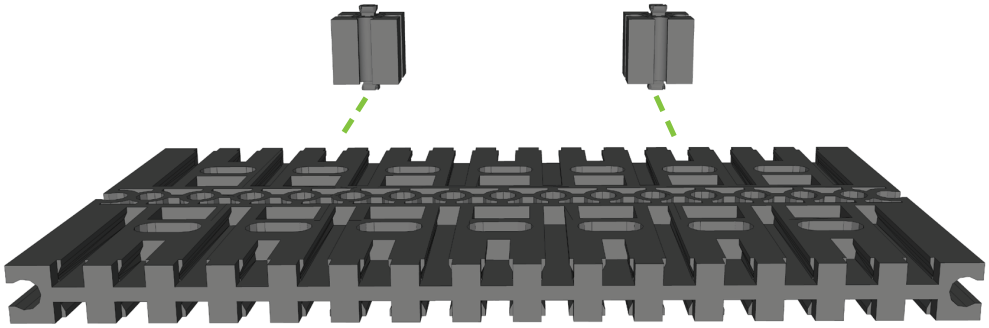


1

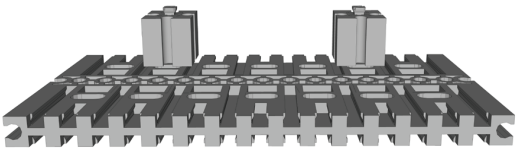

x1


x2

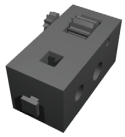
All steps have an "exploded view" which helps with assembly.



The assembly should look like this before proceeding to the next step.

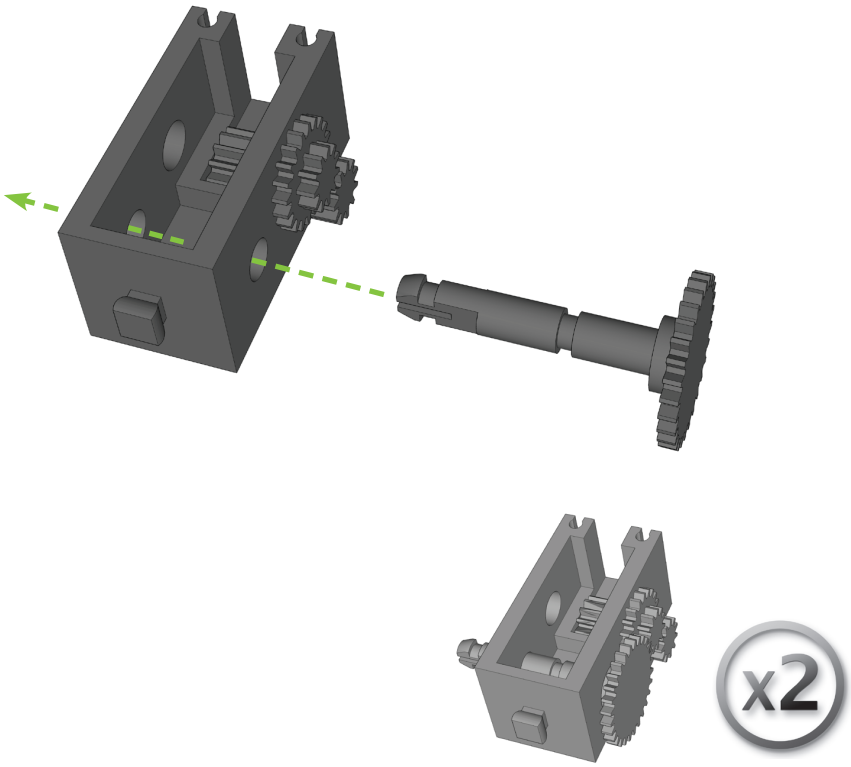


2

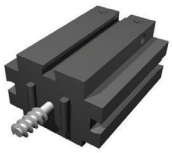


x2

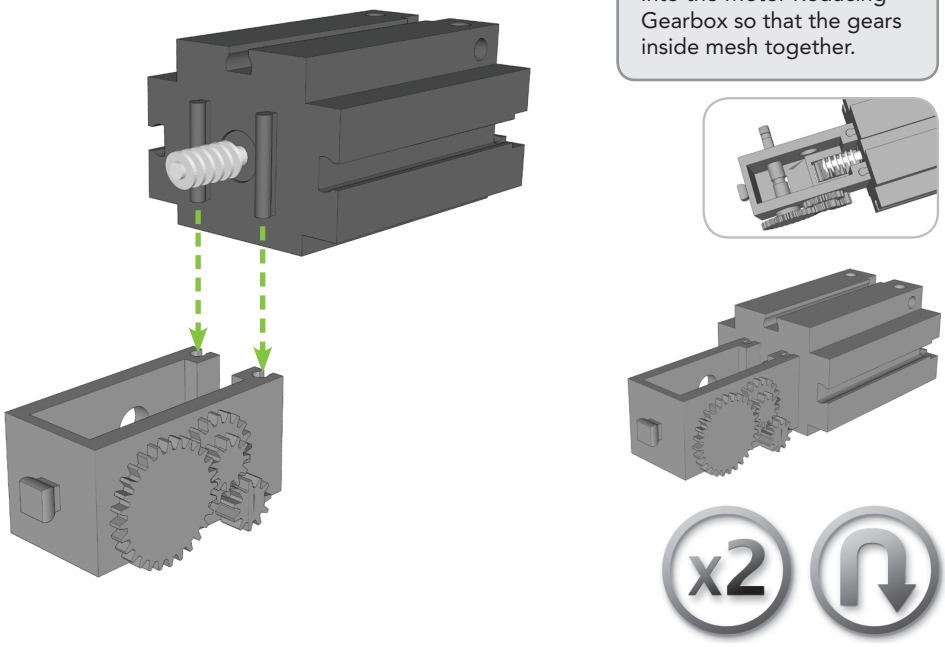
x2



3

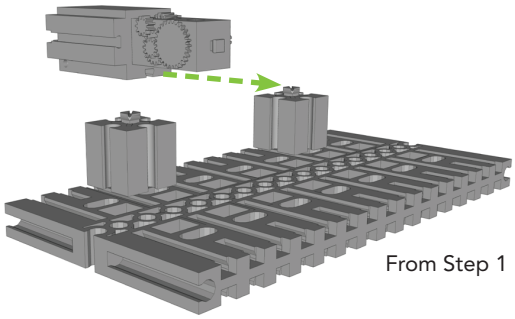


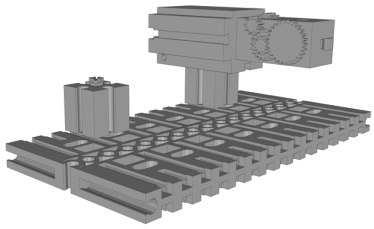
x2



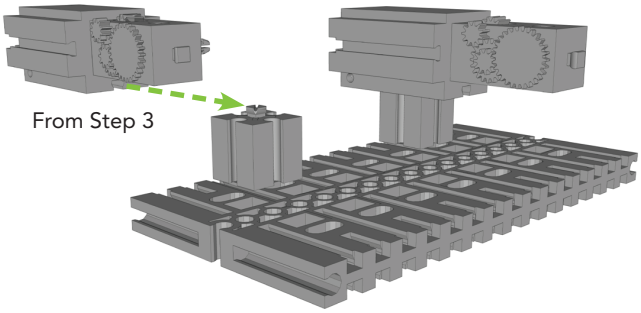
Make sure to slide the Mini Motor 6-9v all the way into the Motor Reducing Gearbox so that the gears inside mesh together.

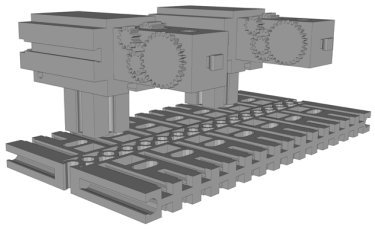
4a





4b

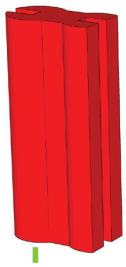




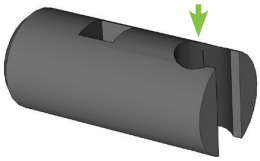
5

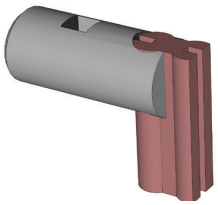
x2

x2

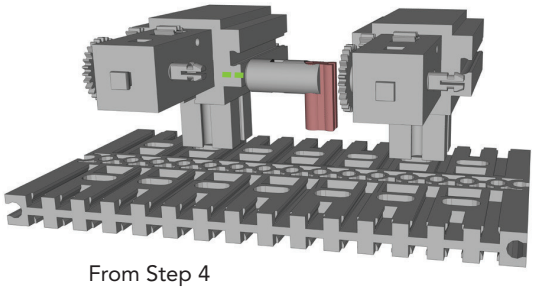


Make sure the round side of the Link 15 is inserted into the Clip Axle.

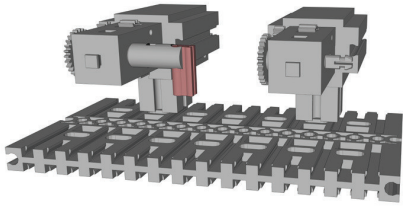




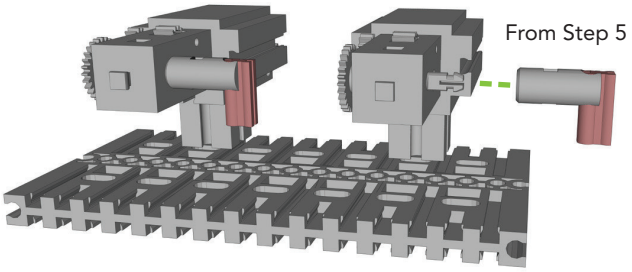
6a



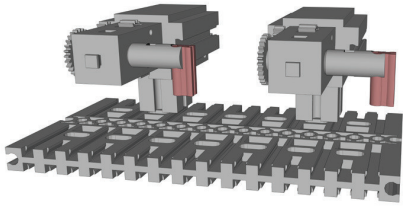
From Step 4



6b

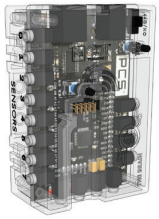


From Step 5



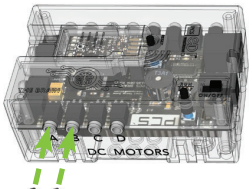
7

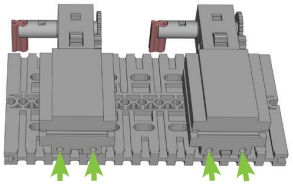
x1



x1

x2



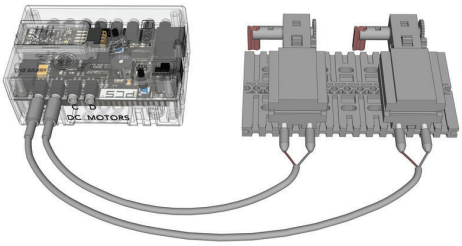


Plug into DC Motor Port A

Plug into DC Motor Port B

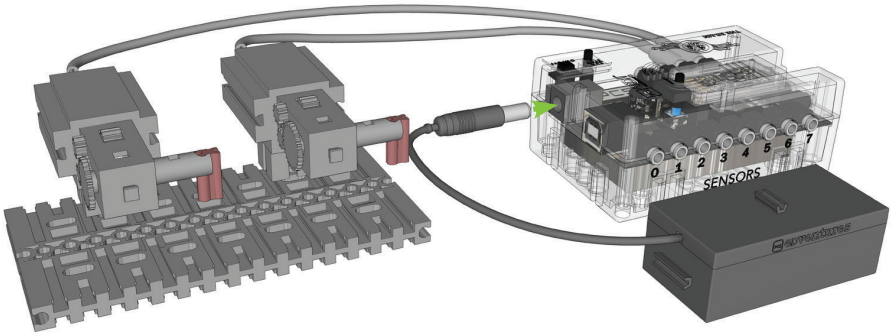
The red wires plug into the left side of the Mini Motors.

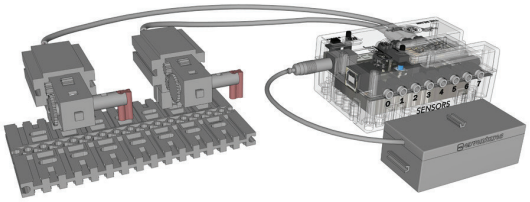
The Dongle should not be attached if Brain is connected to a USB.



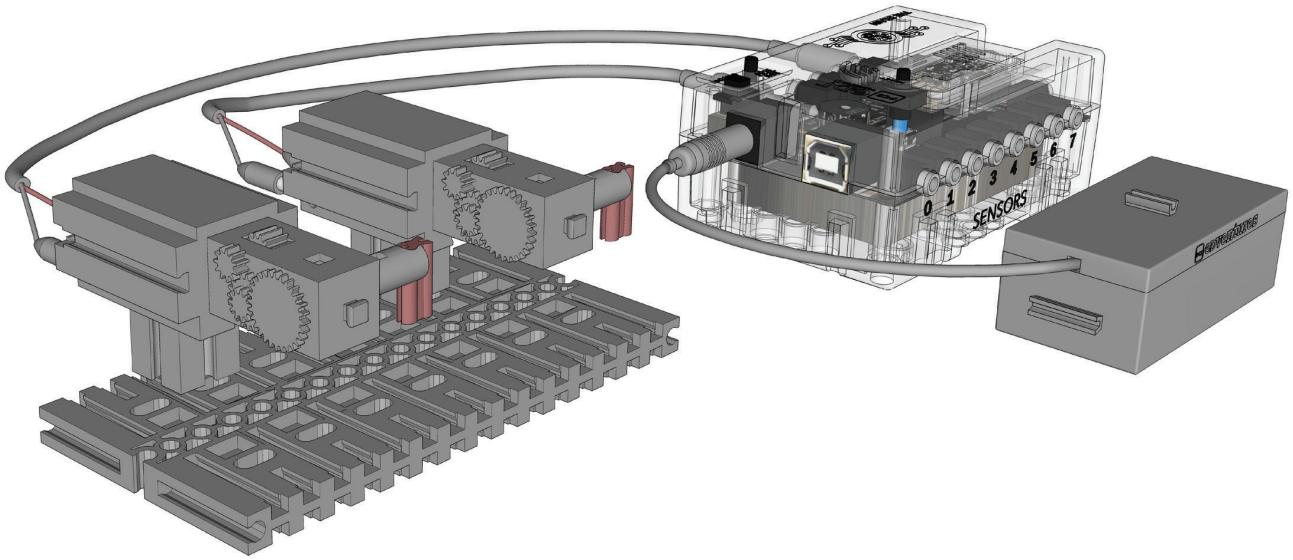
8

x1





Finished Model



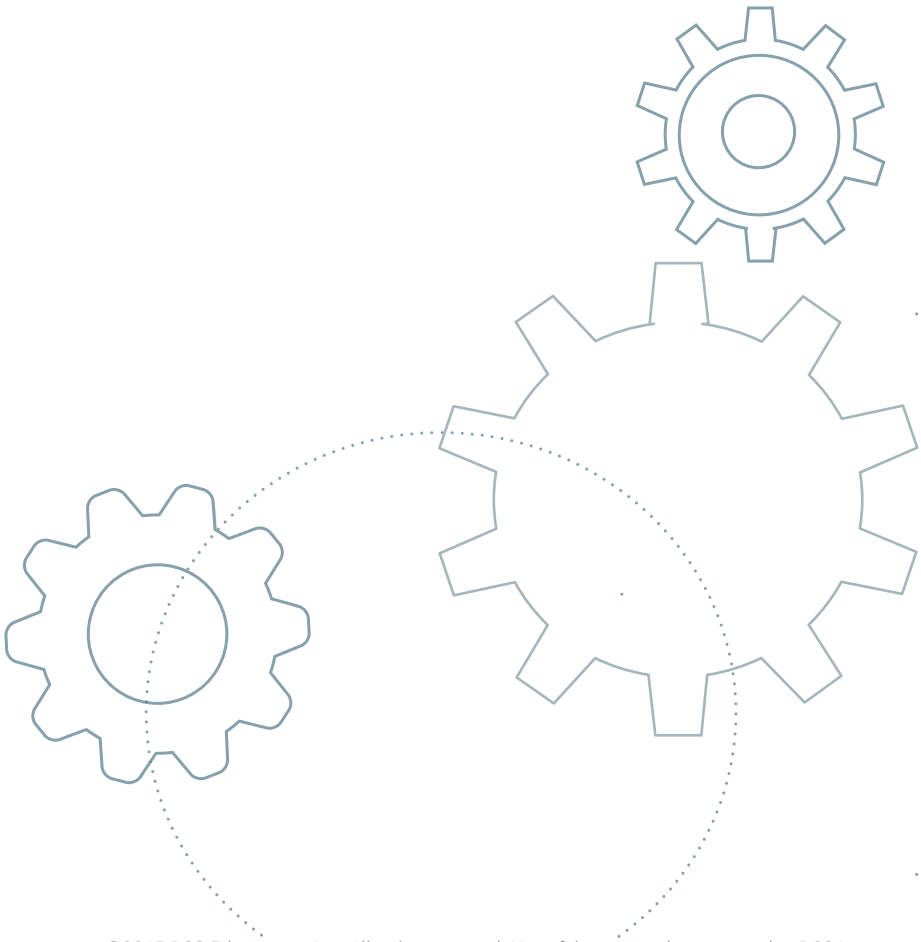
PROJECT 1 (CONT.)

POWERING THE MOTOR TESTING STATION:

- Power The Brain with either a battery or through a power outlet using the DC power cord. The motors are powered through The Brain.

PROGRAMMING THE BRAIN:

- In order to program The Brain, it must be connected to a computer or tablet via USB cable or Bluetooth.
- Physical Connection: Use a USB cable to connect The Brain to a computer that has the Cortex programming environment installed. The Bluetooth Dongle should be removed when using a USB cable.
- Wireless Connection: The Brain and Cortex can also communicate through Bluetooth signal to either a computer or tablet. Make sure the Bluetooth Dongle is attached.
- See page 22 for more details on connecting to your programming device.



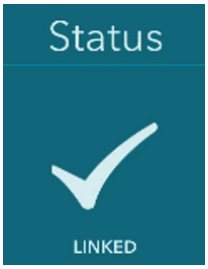
PROJECT 1 (CONT.)

Launch the Cortex programming environment. Click on the different color tabs in the Cortex. Identify the types of commands that are listed in each of the following tabs: orange, red, teal, lime green and purple in the Cortex (example below).

Motor Commands	**ORANGE:** Motor Commands - Your Brain has 4 DC and 4 SERVO motor ports. Access this menu to select and control these DC and SERVO motor ports and set their power, direction and on/off status.
Procedure Commands	**RED:** Procedures - Procedures are sections of code that are created and reused for efficiency. Access this menu to create and call procedures, as well as create and set variables.
Sensor Commands	**BLUE:** Sensors - The Brain has 8 ports for Input and Output (I/O) that allow it to take readings from light, touch and other kinds of sensors as well as send Output signals such as those that light up your LEDs. Access this menu to monitor and control these I/O ports.
Logic Commands	**LIME GREEN:** Loops & Logic - Access this menu to access and integrate important programming features such as looping, repeat statements, if statements and number comparators.
Misc Commands	**PURPLE:** Miscellaneous Access - This menu is for things like notes, beeps and wait commands as well as cosmetically useful spacers to make your program easier to read.

Connect The Brain of the motor testing station to the computer/tablet using either:

1. The Bluetooth device or
2. A USB cable



Enabling Bluetooth: *In order to connect to the Bluetooth function of The Brain, enable the Bluetooth settings on whichever machine (tablet, desktop, laptop) is running the Cortex. First, set the machine to discoverable mode in the Bluetooth settings. Ensure that the Bluetooth dongle is attached to The Brain appropriately. Ensure that power is provided to The Brain with either the provided 9V battery pack, or with the AC/DC power cord (preferred for testing station). The Brain automatically makes itself discoverable, but you may have to instruct your operating machine to look for other Bluetooth devices. The Brain shows up as an option named PCS-BT; select it. Once The Brain is discovered then the machine prompts you to enter a security code. The code is 1234. Once you have established the Bluetooth connection between the operating machine and The Brain, open the Cortex software.* *See page 22.*

Programming

The first step to programming is to write a procedure for the robot to follow. A procedure is a list of commands that when followed in order, communicates a desired outcome.

In the Cortex programming environment, grab commands from different colored tabs inside the menu and drag them into the program.

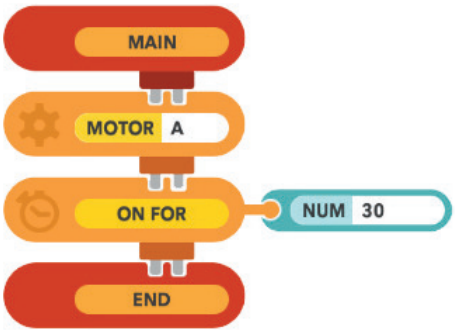
To include commands into the program they must appear in between the **MAIN** and **END** commands.

Let's write our first program!

To program motors, identify each motor (using the **MOTOR** command) and tell them to turn on (**ON FOR** command). The "name" of each motor is the port it is plugged into (i.e. the motor plugged into port A is motor A).

Find the **ON FOR** command under the orange tab and drag it into place between the **MAIN** and **END** commands.

The **ON FOR** command has an arm extending off of it's side, like many of the commands in the Cortex. This signifies that there is additional information required for this command to function.



Under the blue tab find the **NUM** (number) variable. **NUM** is a value that can be adjusted up or down by selecting the value inside. If the **NUM** is connected to the arm of the **ON FOR** command then it completes the request. Double click on **NUM** to adjust the value.

Send the program to The Brain. What happens?

Then switch the red and black **cables** into opposite holes of the motor.

This changes the **polarity** (the direction electrons are flowing through the motor, and therefore the direction of the motor).

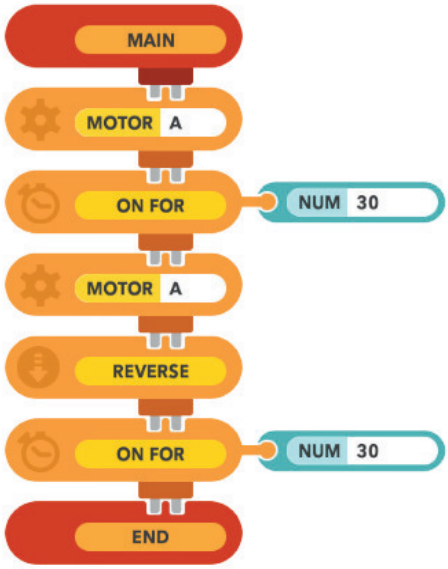
Run the program and note the direction the motor turns this time.

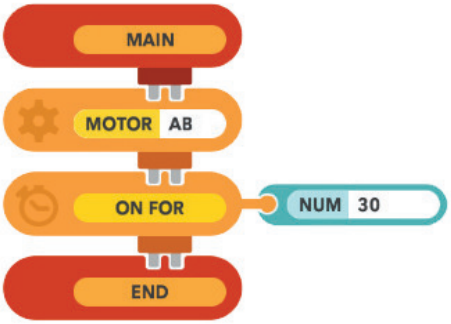
More programming!

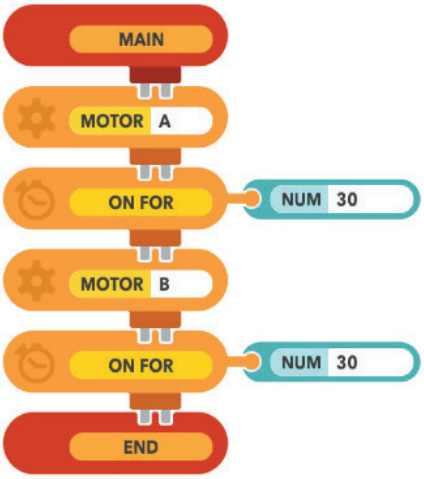
Motors default to run in a particular direction, so as long as the DC motor **cables** are attached the same way, both motors turn in the same direction. The **REVERSE** command switches the direction the motor turns.

Program the motor testing station by recreating each of the following programs, one at a time, in the Cortex.

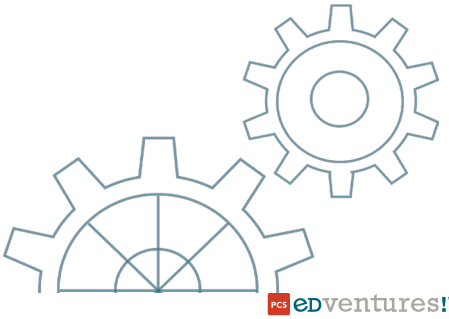
After each program is created, send it to The Brain and note what happens. Is it what was expected? If unsure, run the program multiple times by pressing **RUN** in the Status Bar, or by pressing the **RUN/STOP** button on The Brain.







Can you read your program and see why the motor is doing what it is doing? If not, talk it over with a peer and be sure you understand before moving on. For the next challenge, create codes using this same computer language.



Challenge 1

Create Three Programs

Using the motor testing station, create three separate programs to do the following:

Program 1: Make motor A run for 10 seconds and Motor B run for 5 seconds.

Program 2: Make motor B run for 5 seconds and then reverse for 8 seconds.

Program 3: Make motors A and B run simultaneously for 5 seconds and then reverse simultaneously for 5 seconds.

Adjust the value of **NUM** such that the flag attached to motor A spins around exactly 3 times and stops where it started.

Try the same challenge for motor B. Is the value that was used for motor A lesser (<), greater (>) or equal (=) to the value used in motor B for the same result? Explore the answer in the next challenge.

Reflect

Now that you created your first programs, respond to the following prompts:

1. Which of the three programs was most difficult to create? Why?
2. Imagine you are going to coach another student who is about to repeat this challenge. Make a list of "tips and suggestions" for that student. Think about both the construction of your motor testing station and programming it.
    a. Exchange your list with a classmate.
        i. Give your companion feedback about how clear their list is (how easy it is to follow).
        ii. Think about the items in their list that differ from your own. Are there any that you would like to add to your list?
    b. Collaborate in your pair group on one or two of the most important tips from your lists and record them in the class list on the board.