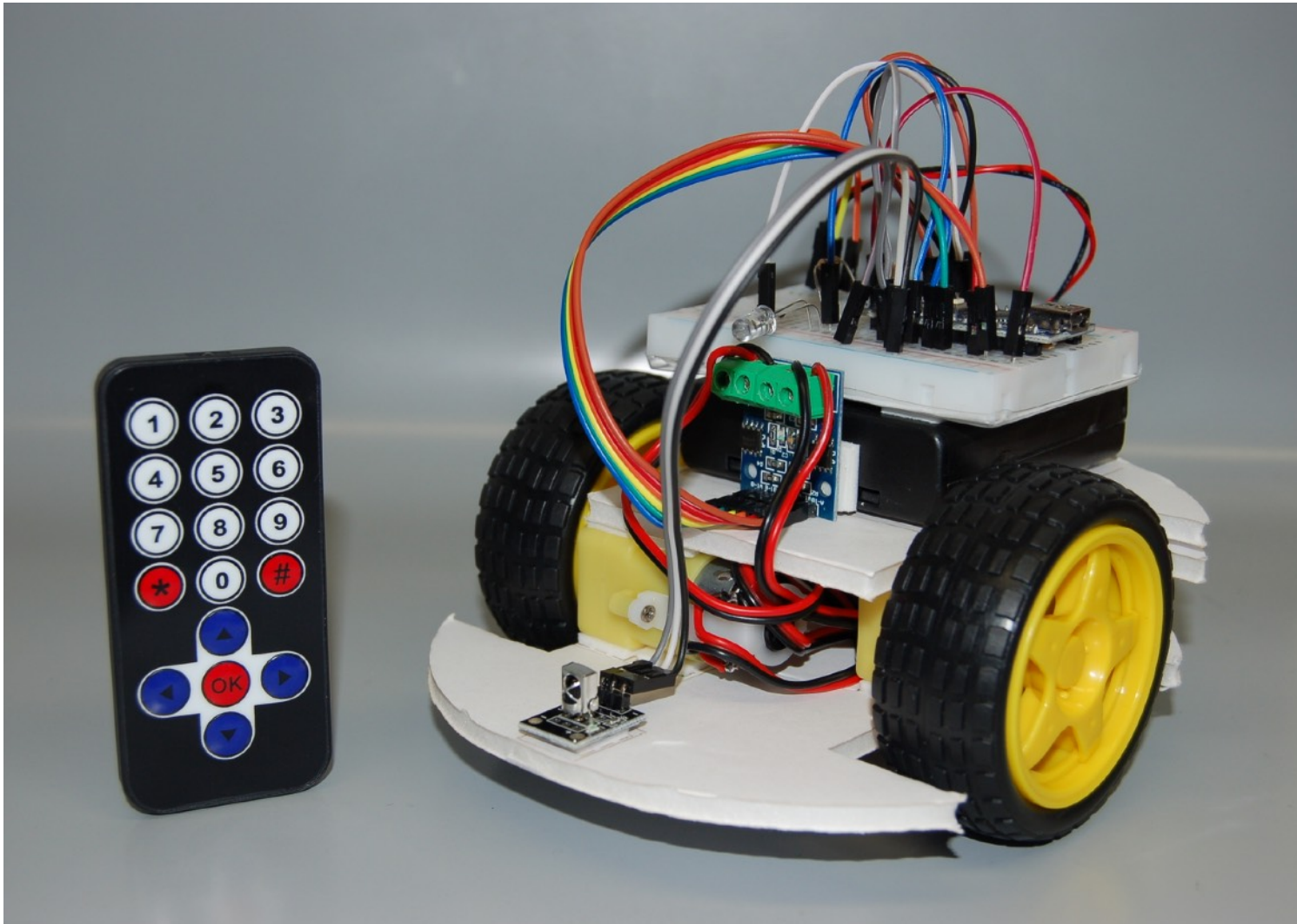
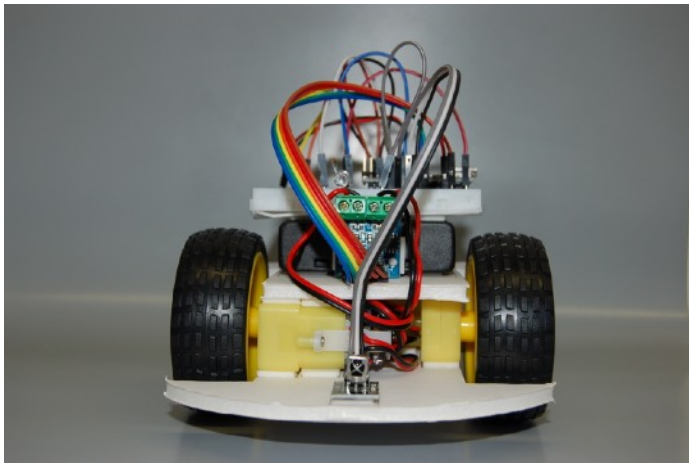


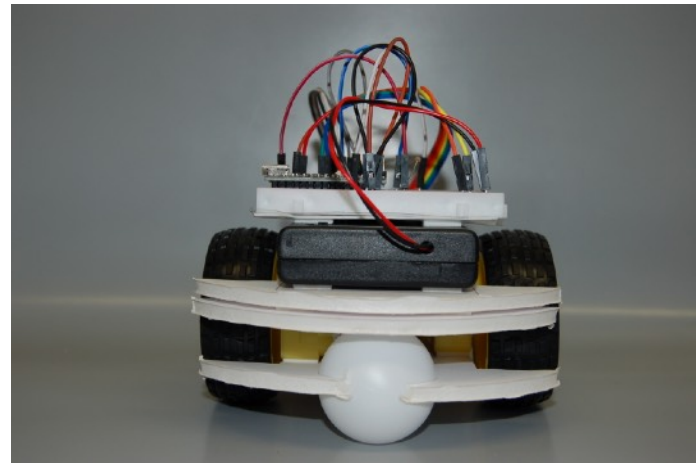
# 2020 Bot Kit

## Assembly Instructions

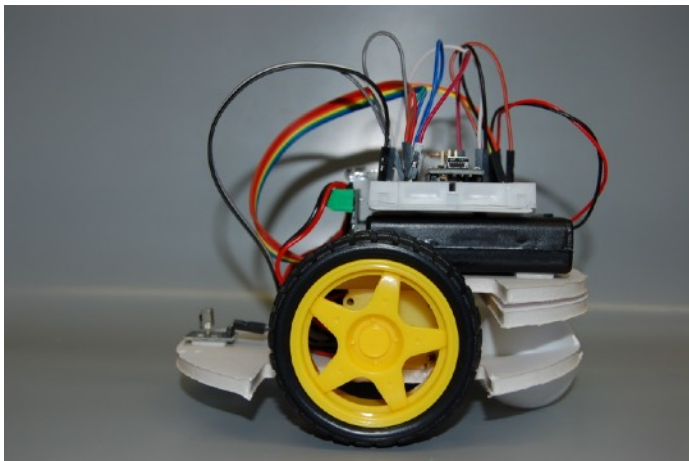




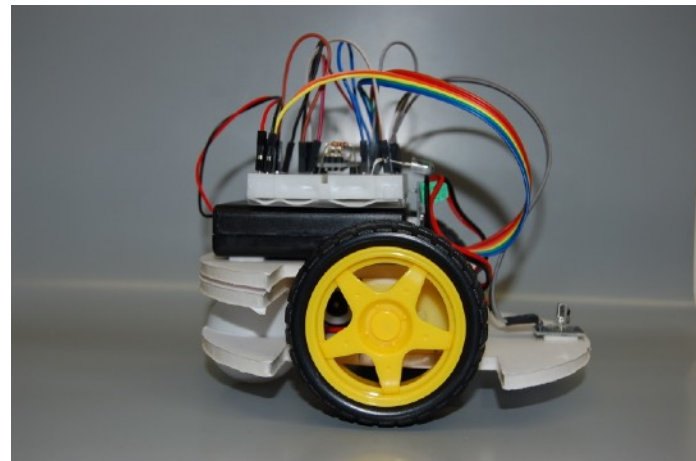
Front View



Back View



Left View

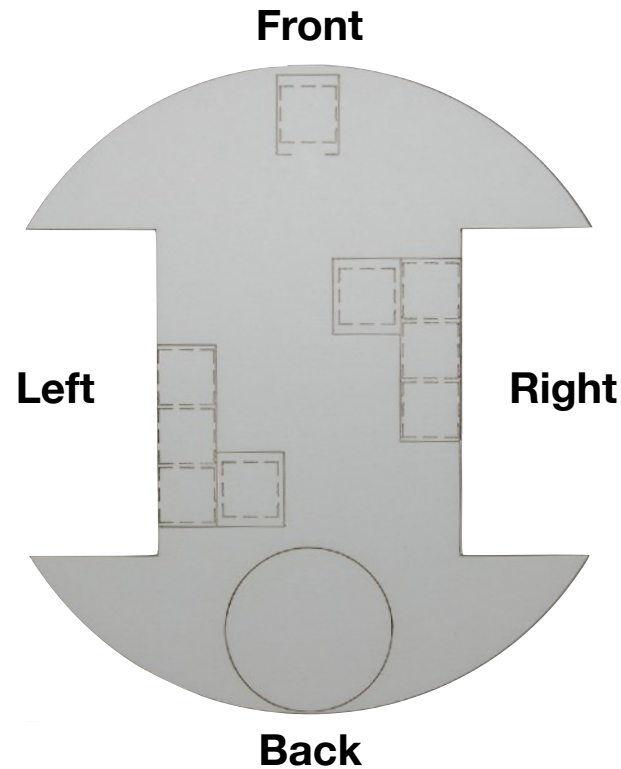


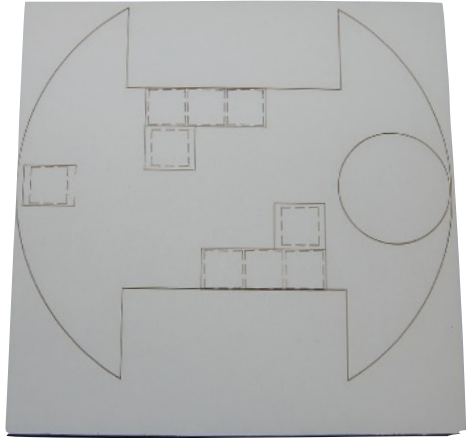
Right View

## Step 1: Part Identification

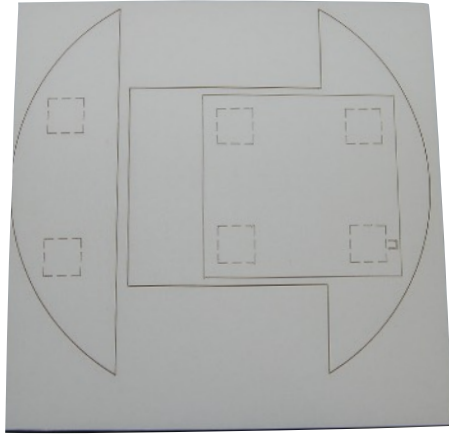
Before you get started, take a look at the part pictures and descriptions. Make sure you have all the parts, and know what they're called.

Robot orientation - for reference:





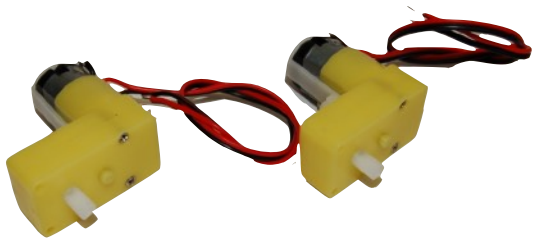
Base Plate  
Pre-cut Foam Board



Battery Mount and Spacer  
Pre-cut Foam Board



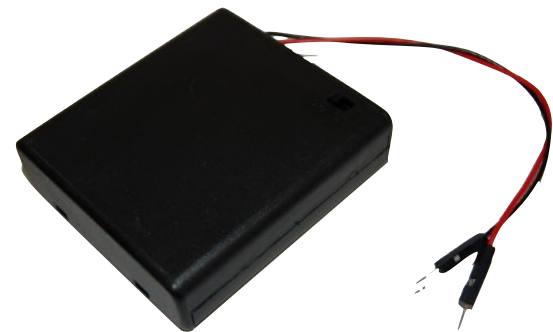
Ping Pong Ball



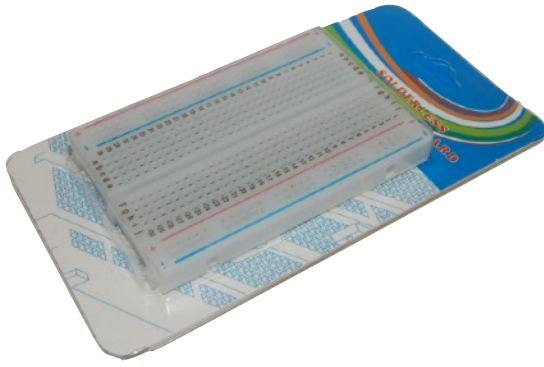
(2) Yellow 1:120 Gearboxes  
with 6V Motors



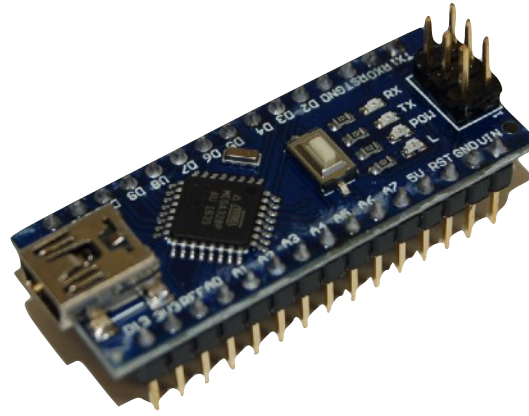
(2) Wheels



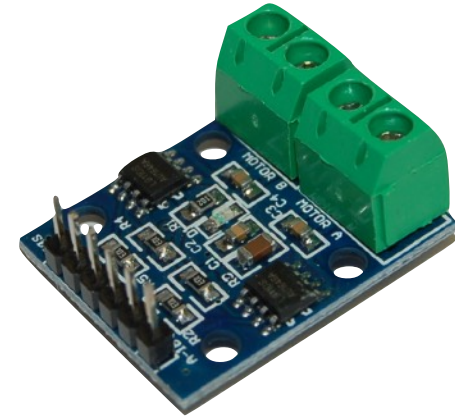
4xAA Battery Box with Switch



400 Point Solderless Breadboard



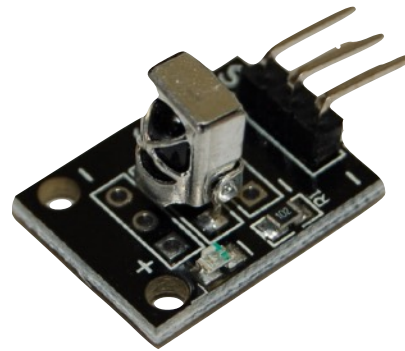
Arduino Nano



L9110S Dual Motor Driver




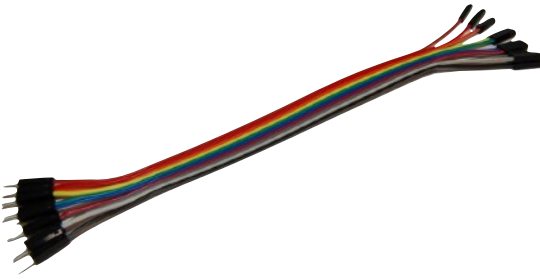




IR Remote Control



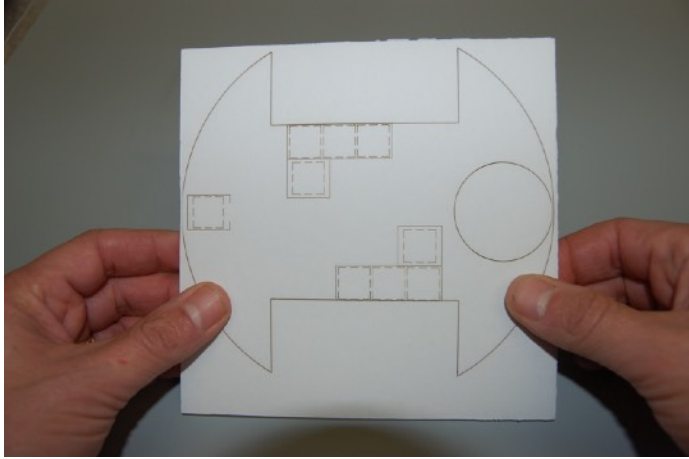
IR Receiver Module



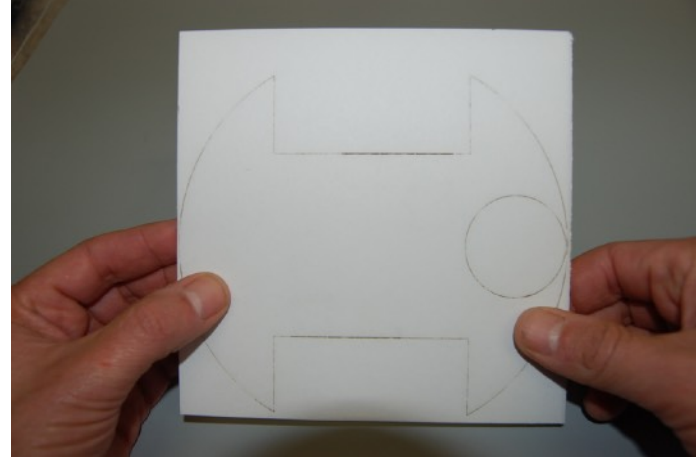
IR LED

		
<p>1K Resistor</p>	<p>(10) 20cm Male-Female Jumper Wires</p>	<p>(10) 10cm Male-Male Jumper Wires</p>
		
<p>(30) 1/2" Square Double Sided Tape</p>	<p>USB Cable</p>	<p>Screwdriver</p>

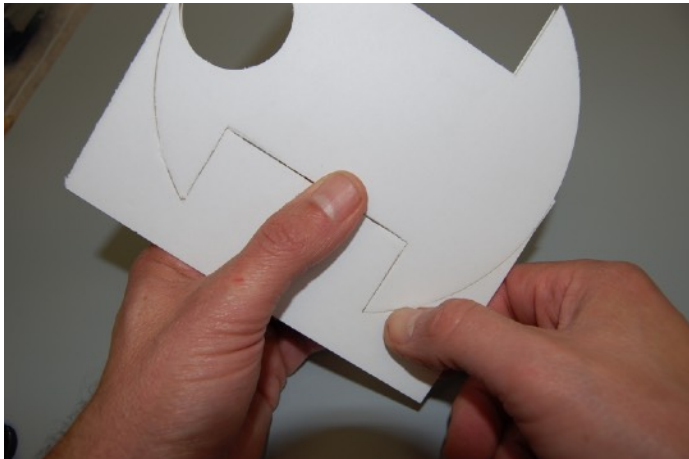
## Step 2: Punch Out Chassis



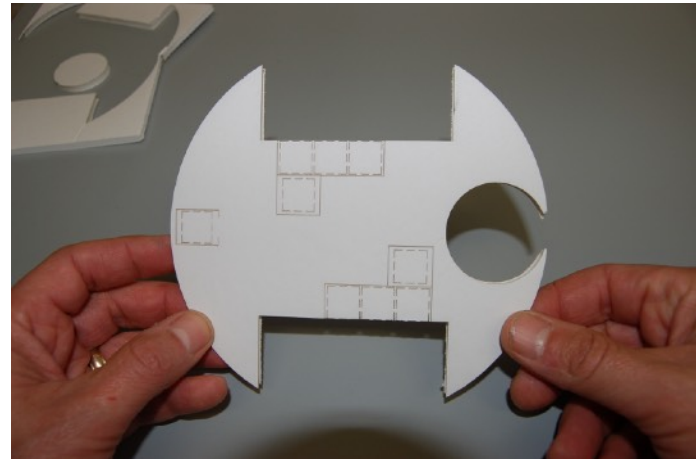
Find the Base Plate.



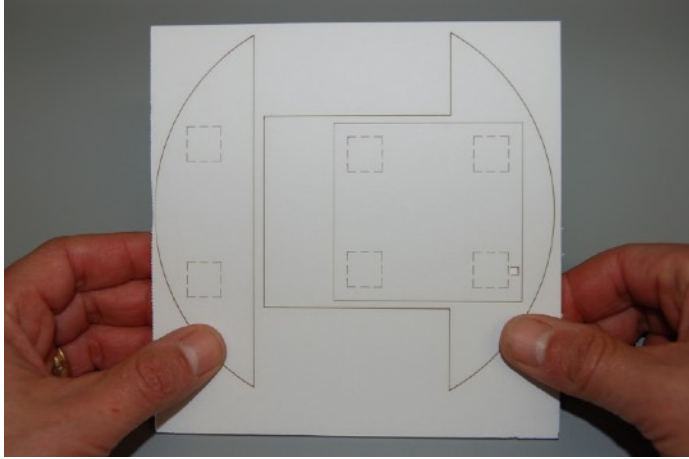
Flip it over.



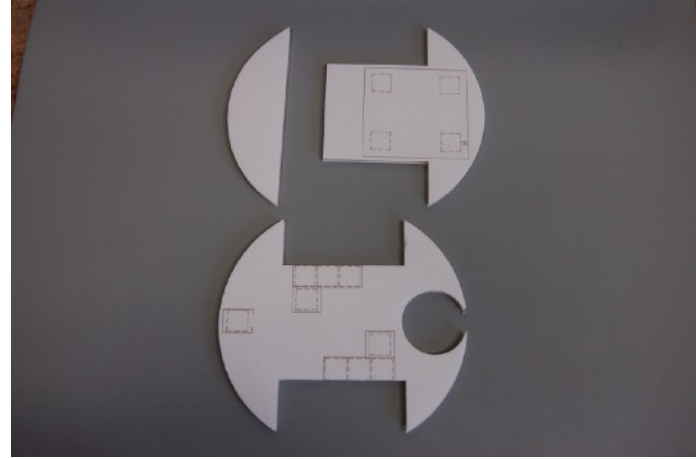
Carefully separate the Base Plate.  
Use the edge of your fingernail to avoid tearing.



Base Plate is ready!

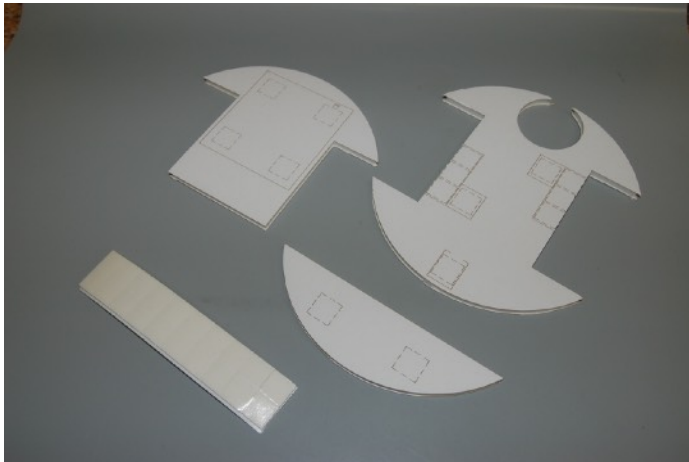


Do the same process to carefully separate the Battery Mount and Spacer.

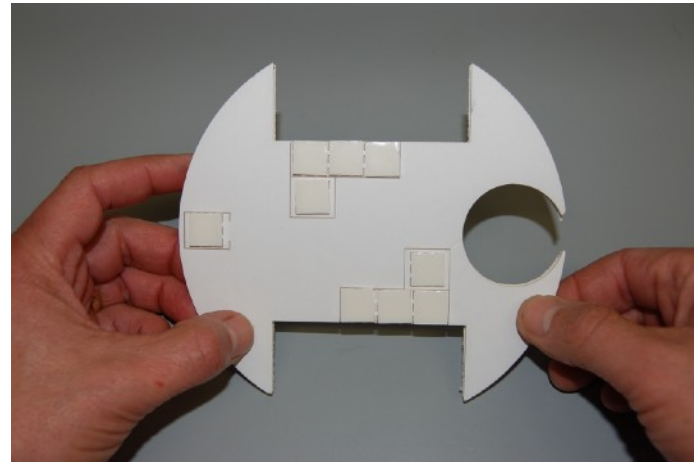


Ready for the next step!

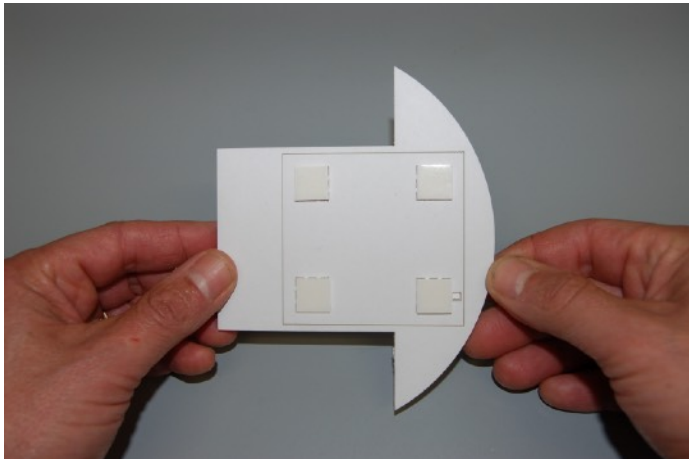
### Step 3: Add Double Stick Tape



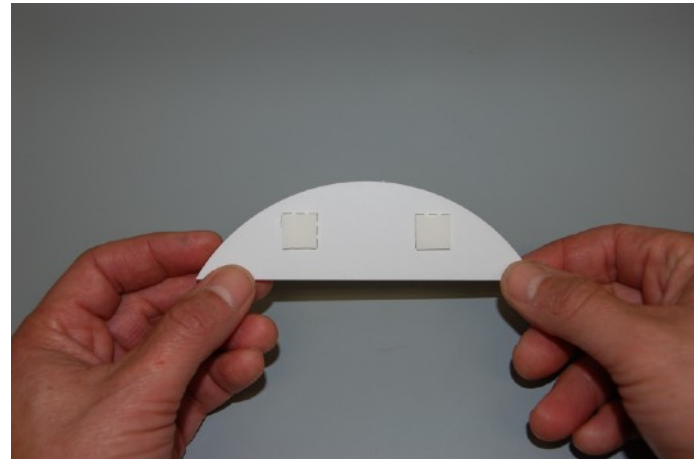
Add double stick tape squares to each of the dashed locations on the Base Plate, Battery Mount, and Spacer.



Base Plate (9 squares)



Battery Mount (4 squares)

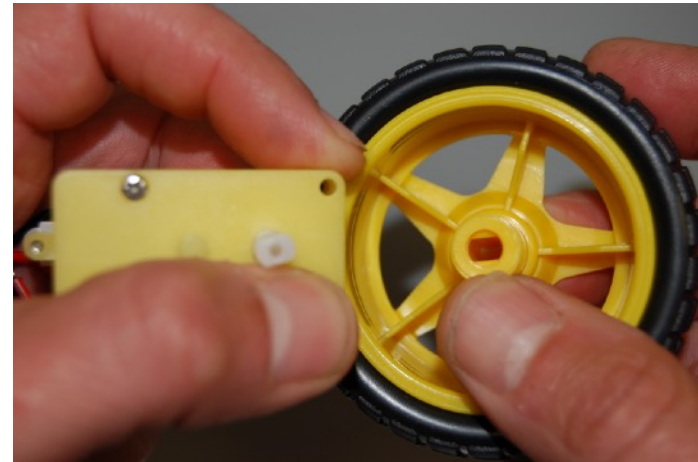


Spacer (2 squares)

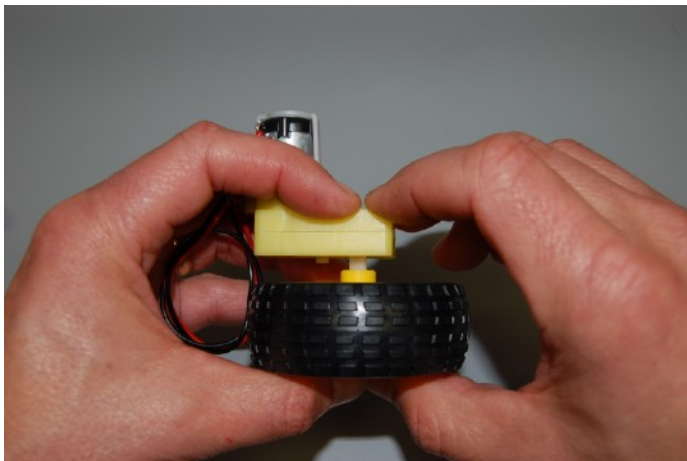
## Step 4: Attach Wheels to Motors



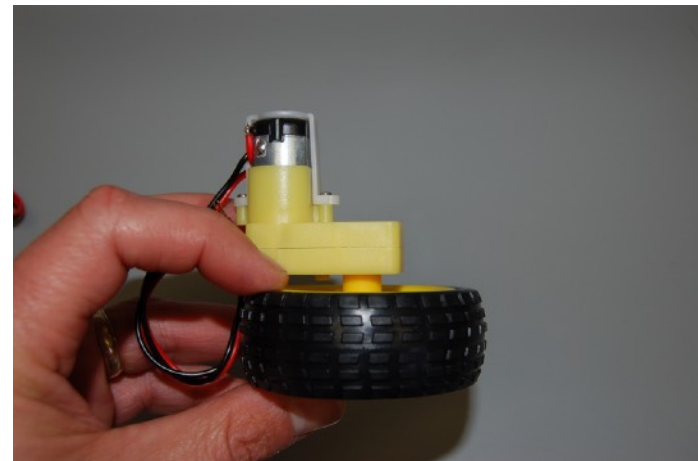
Find the two motors and wheels.



Notice that the motor shaft and wheel hole have flat edges that must be lined up.

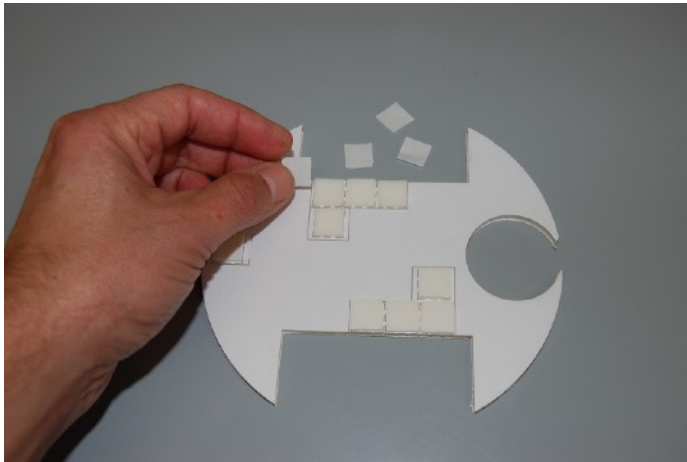


Once the wheel is slightly on the shaft, push it the rest of the way on using equal pressure from top and bottom.

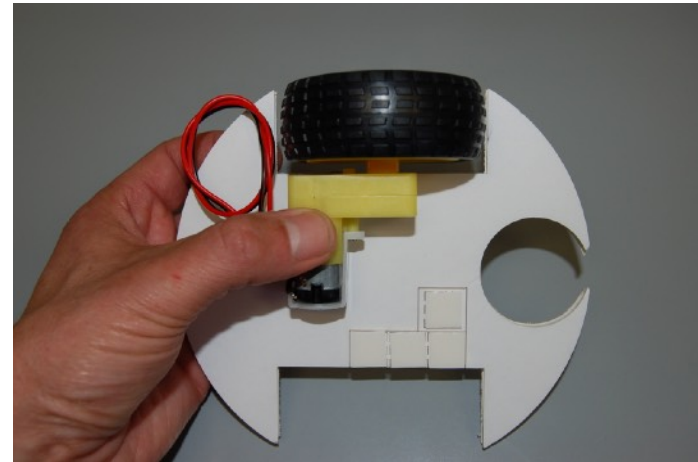


The motor shaft should not be visible when the wheel is pressed on all the way. Repeat for other set.

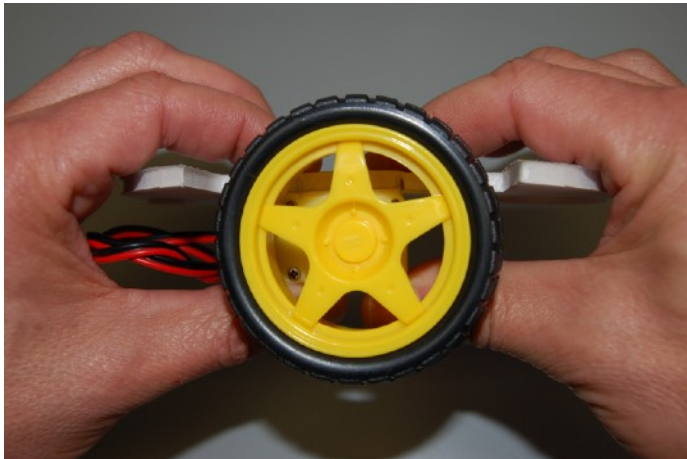
## Step 5: Stick Motors to Base Plate



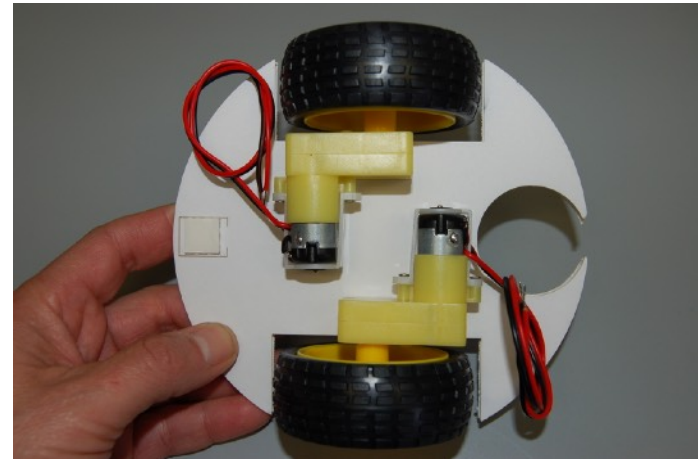
Remove tape covering.



Carefully align the motor to the outline on the Base Plate. Once in position, gently press the motor into the tape.

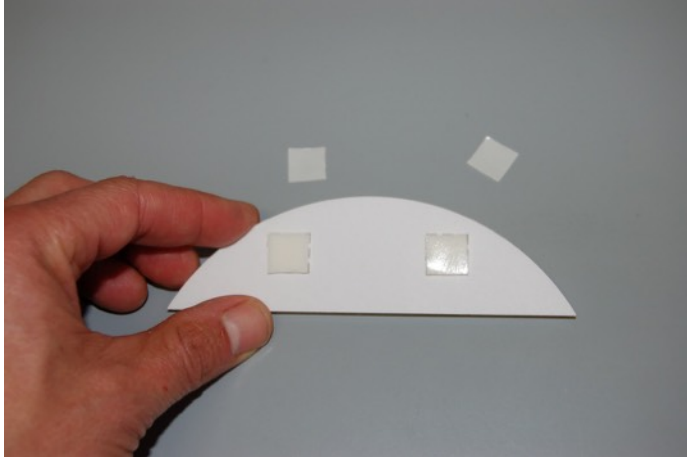


Using equal pressure, gently ensure the motor is making contact with the tape.

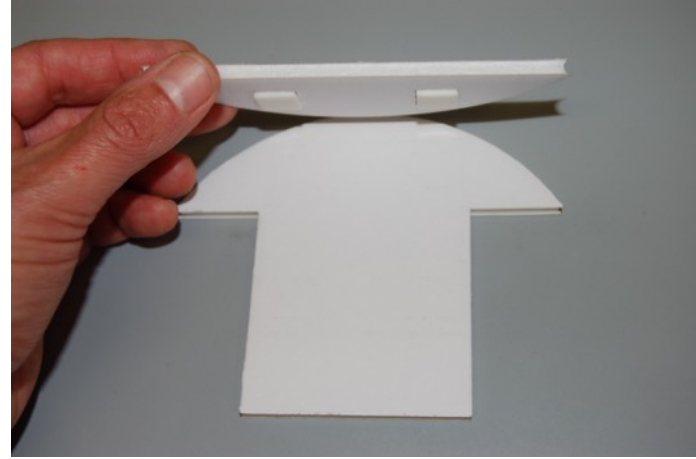


Repeat for the other side.

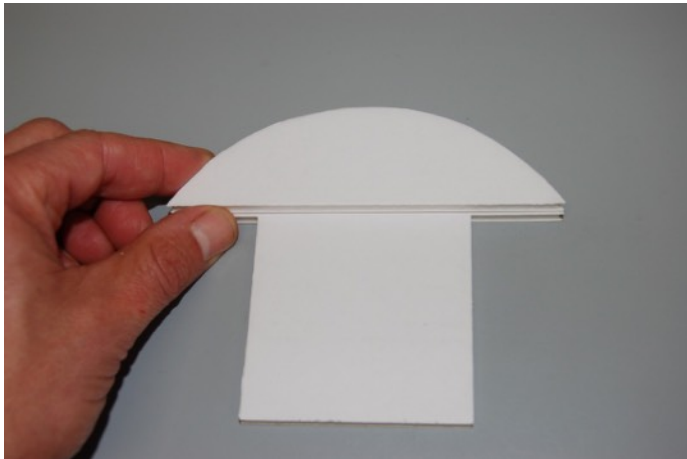
## Step 6: Attach Spacer to Battery Mount



Remove tape coverings from the Spacer.

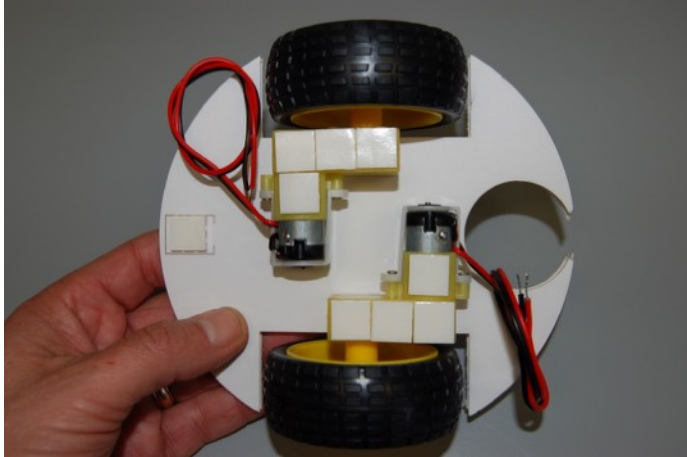


Carefully align the Spacer to the **BACK SIDE** of the Battery Mount.

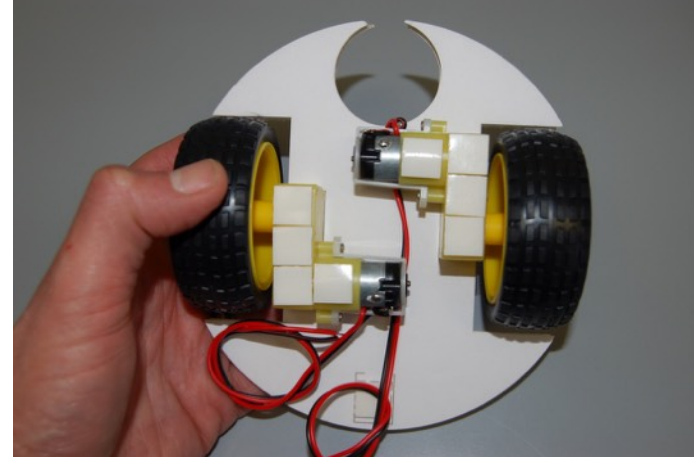


Once aligned, gently press the two pieces together.

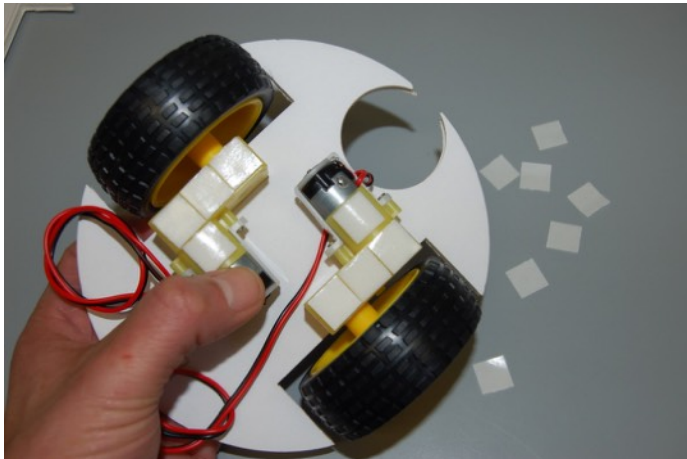
## Step 7: Motor Prep



Add 4 tape squares to the top of each motor as shown.

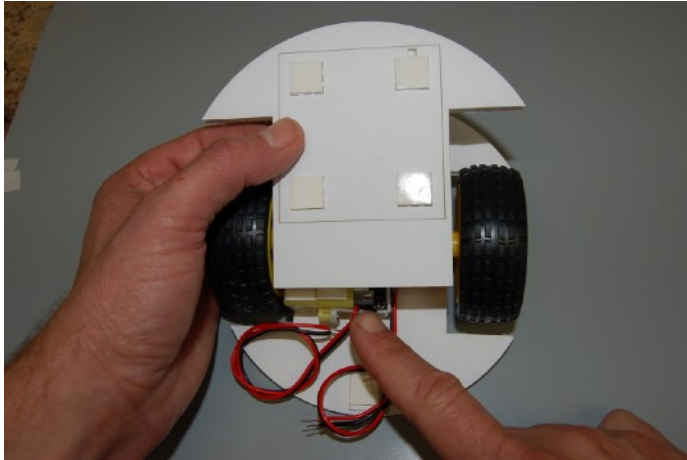


Route the motor wires towards the front of the robot.

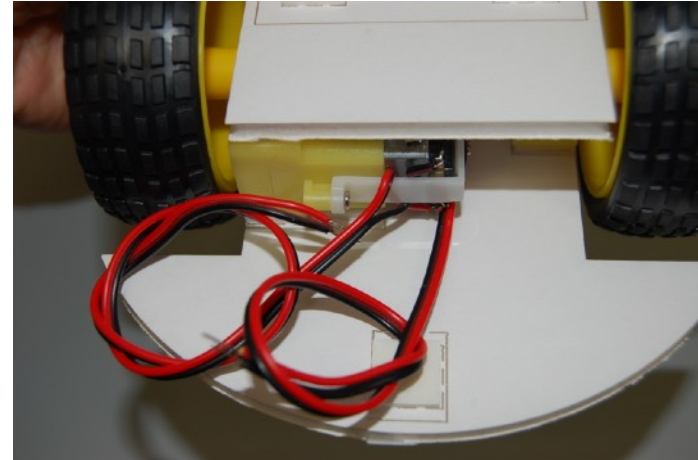


Remove tape coverings from the motors.

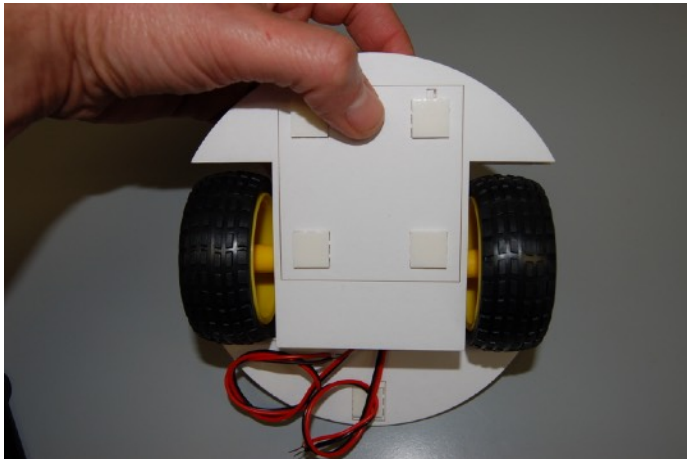
## Step 8: Attach Battery Mount to Motors



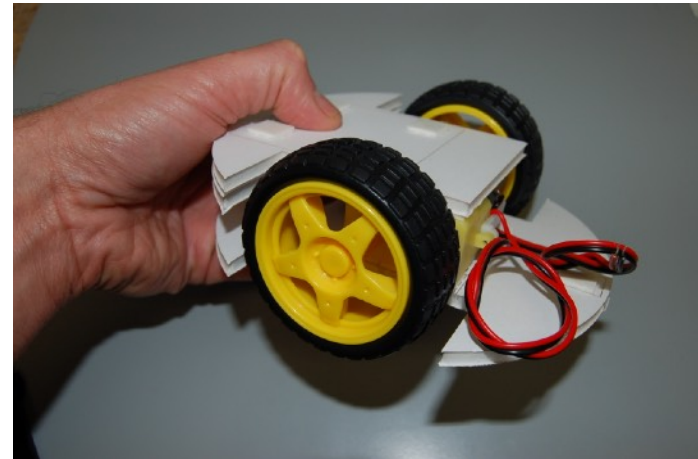
Align the front flat edge of the Battery Mount with the edge of the front motor.



Align the left and right edges with the top of each motor. Carefully press into place with even pressure.

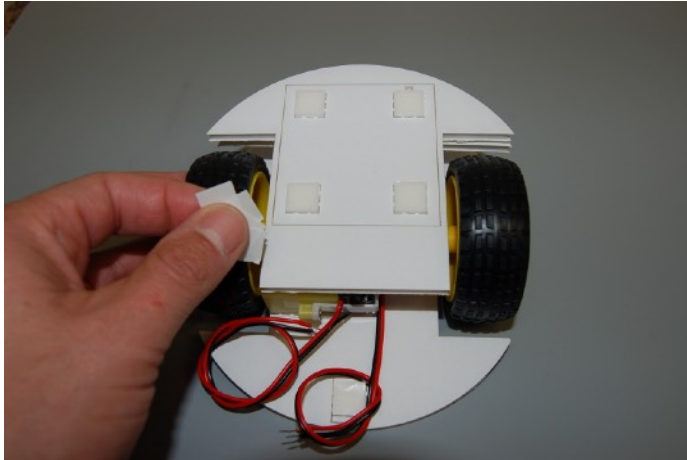


The Battery Mount and Base Plate should align with each other.



Looking good!

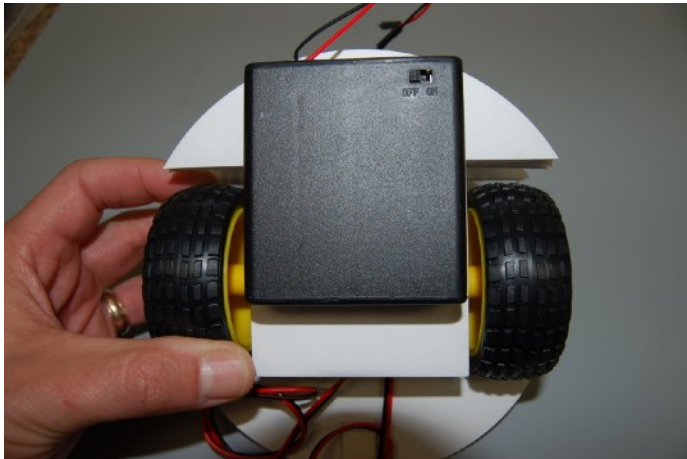
## Step 9: Attach Battery Box



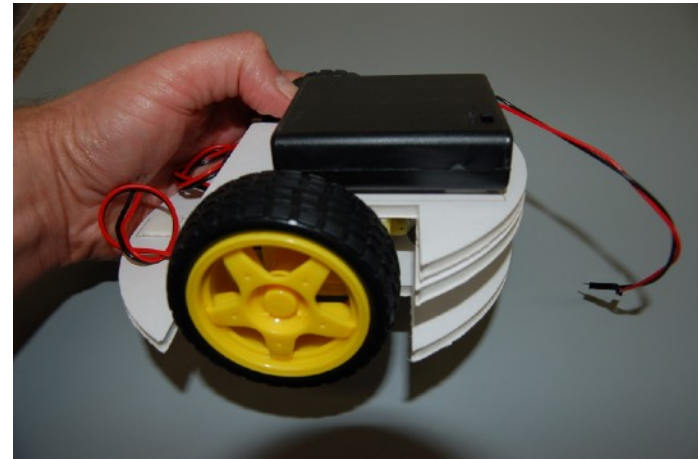
Remove tape coverings.



Be sure to align the Battery Box Switch with the location as marked.



Carefully align the Battery Box with the outline and gently press into place.



Robot power!

## Step 10: Attach Solderless Breadboard

There are a couple ways to attach the Breadboard to the Battery Box, depending on what your future plans may be for reusing the electronics.

**10A:** This is the best method if you definitely plan to reuse the Breadboard, but it does not stay attached to the robot very well.

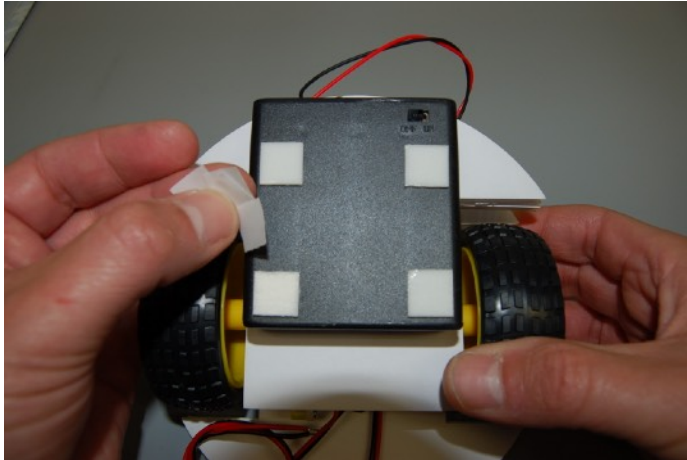
**10B:** You will be able to remove the Breadboard from the battery box to use on other projects, but may need to peel off remains of the tape squares.

**10C:** This is the easiest method and most secure method, but the Breadboard will be permanently mounted to the Battery Box.

### **-PICK ONE METHOD-**

You could start with 10A. If that doesn't work well, try 10B or 10C.

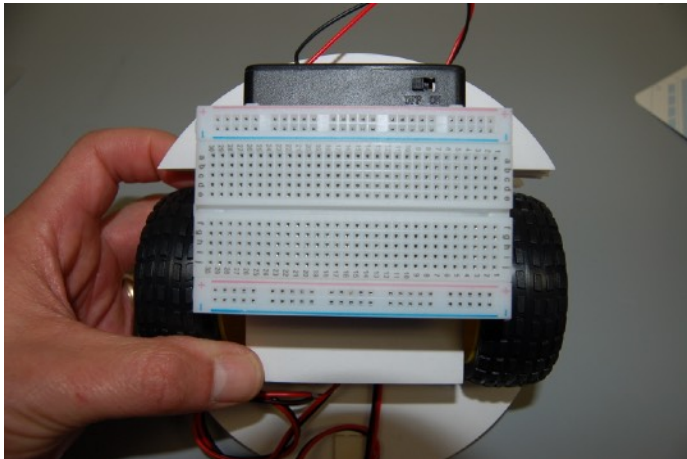
## Step 10A: Least Secure - Best for Reuse



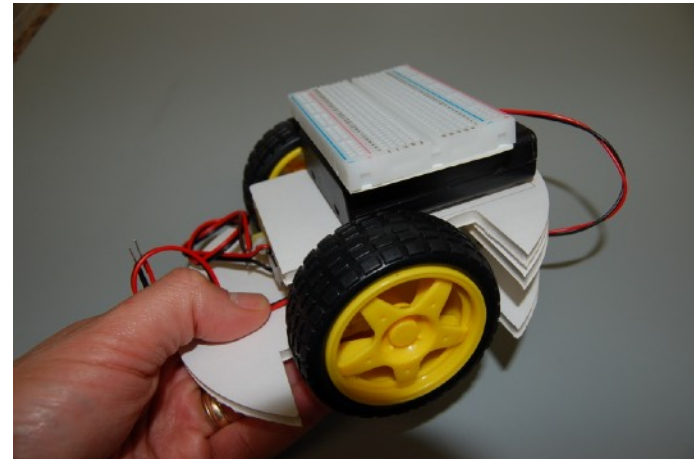
Place 4 tape squares on the Battery Box at the locations shown. Remove tape coverings.



Take the Breadboard out of its package. DO NOT remove the tape covering on the back of the Breadboard!

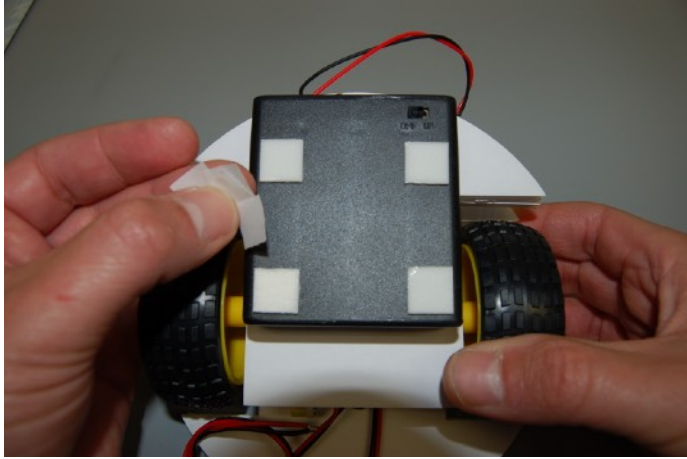


Rotate the Breadboard so that hole position a1 is near the switch.



Align the Breadboard to the front edge of the Battery Box, carefully center left/right, and gently push in place.

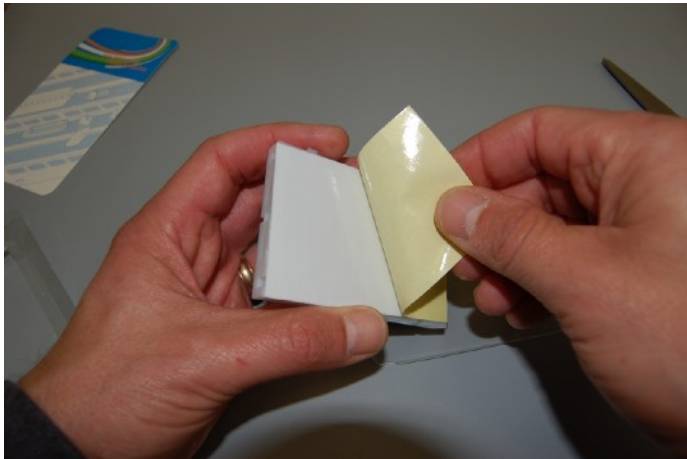
## Step 10B: More Secure - OK for Reuse



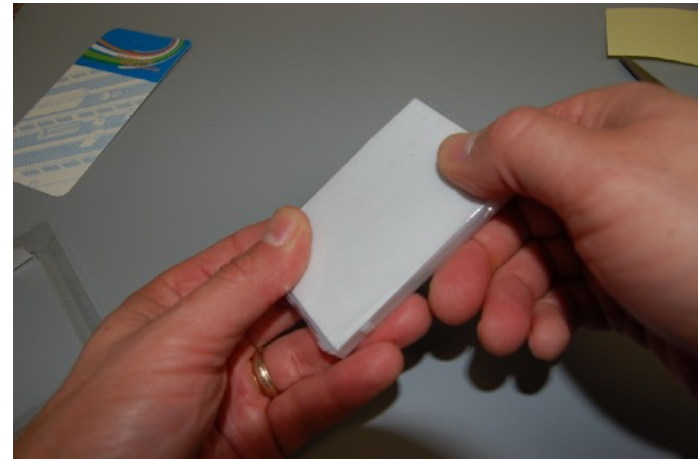
Place 4 tape squares on the Battery Box at the locations shown. Remove tape coverings.



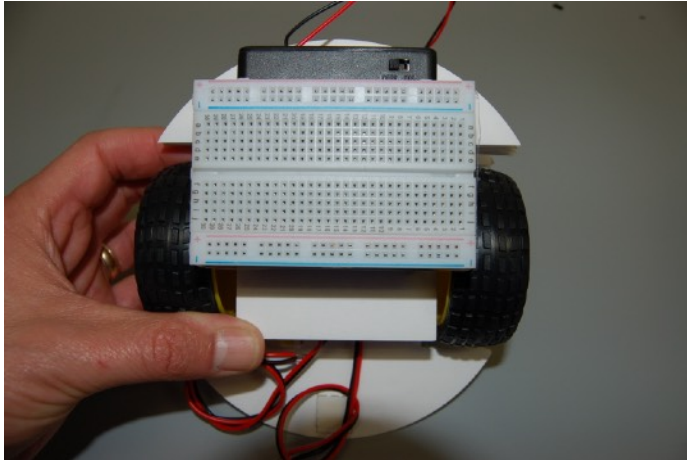
Cut out the plastic rectangle from the Breadboard packaging.



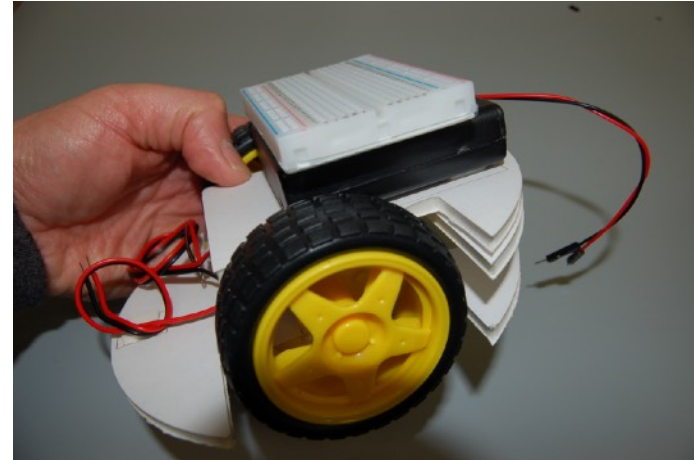
Remove the tape covering from the back of the Breadboard.



Press the plastic rectangle on to the back of the Breadboard.

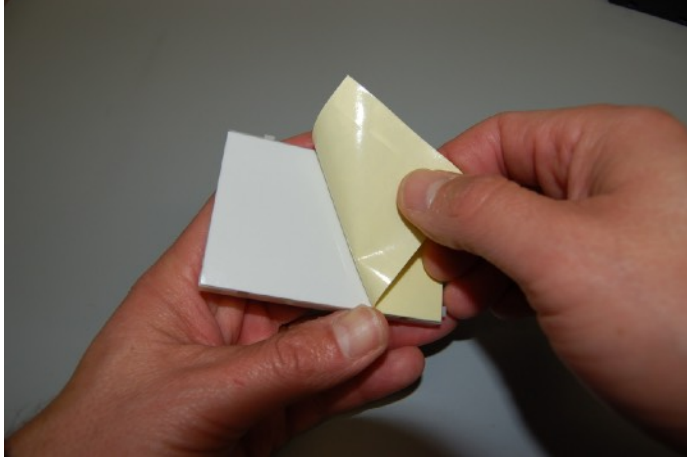


Rotate the Breadboard so that hole position a1 is near the switch.

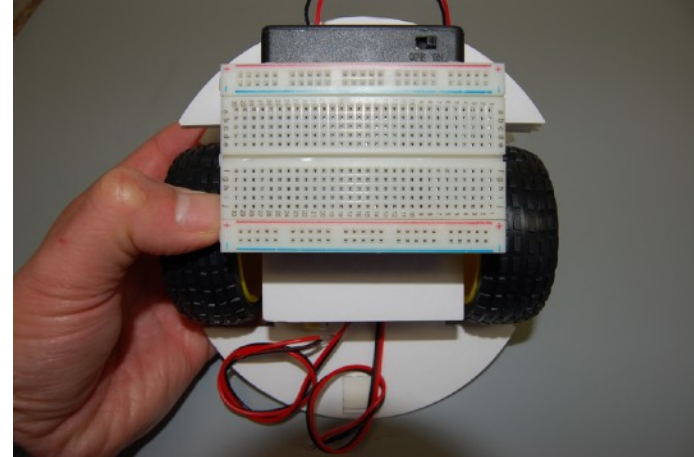


Align the Breadboard to the front edge of the Battery Box, carefully center left/right, and gently push in place.

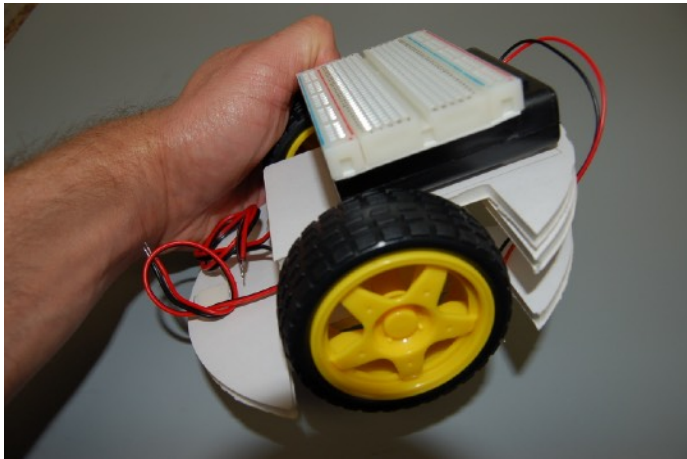
## Step 10C: Most Secure - Breadboard and Battery Box Permanently Attached



Remove the tape covering from the back of the Breadboard.

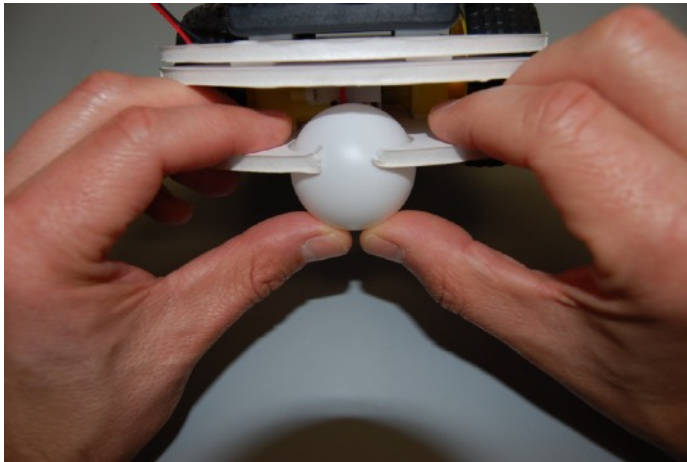


Rotate the Breadboard so that hole position a1 is near the switch.

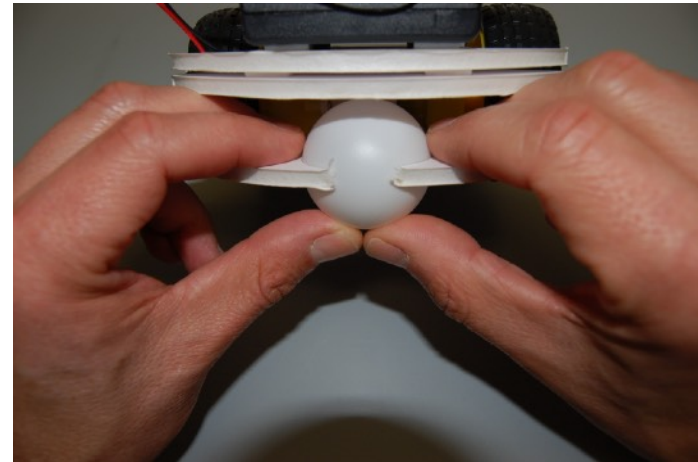


Align the Breadboard to the front edge of the Battery Box, carefully center left/right, and gently push in place.

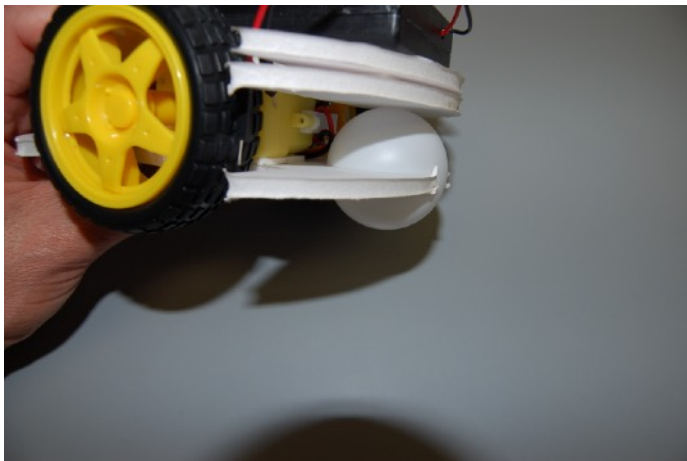
## Step 11: Insert Ping Pong Ball



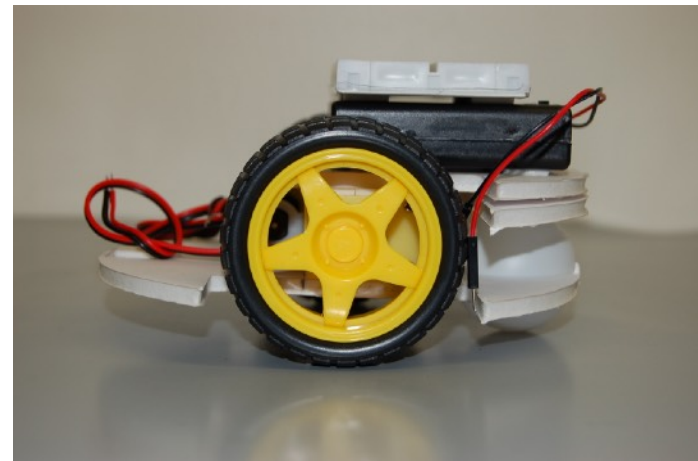
Push the top of the Ping Pong Ball into the hole.



Using gentle pressure on the Ball, and providing support to the Base Plate from above, press into place.

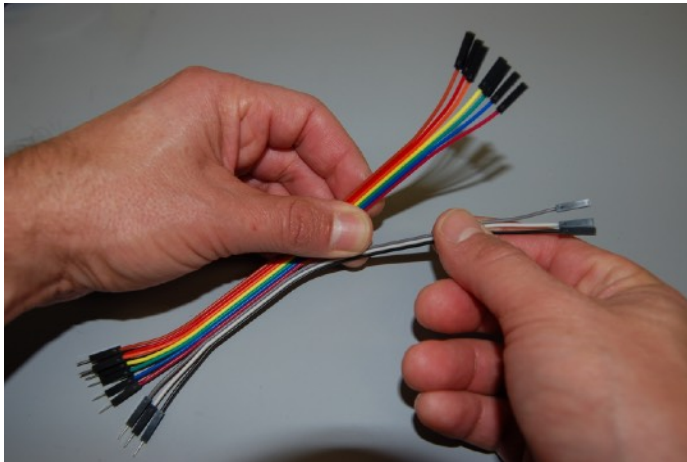


The Ping Pong Ball should insert all the way to the Spacer.

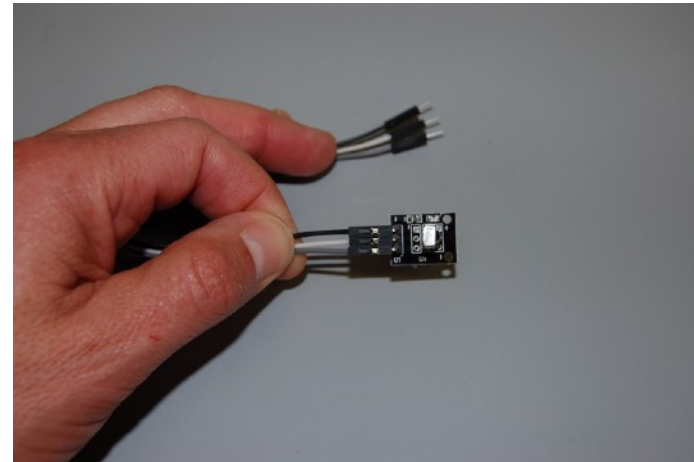


Here you go!

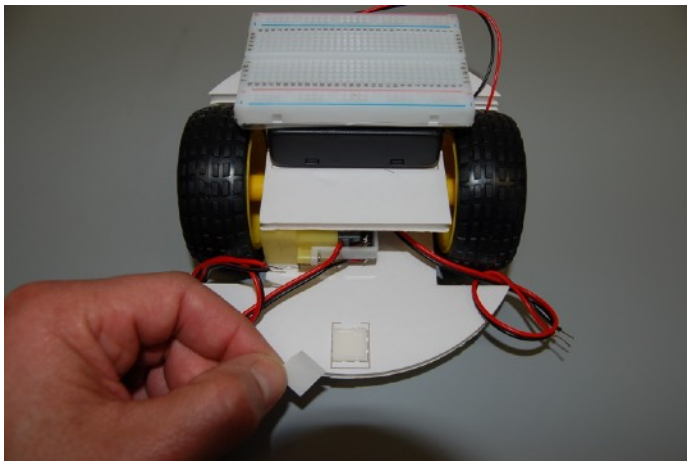
## Step 12: IR Receiver Module



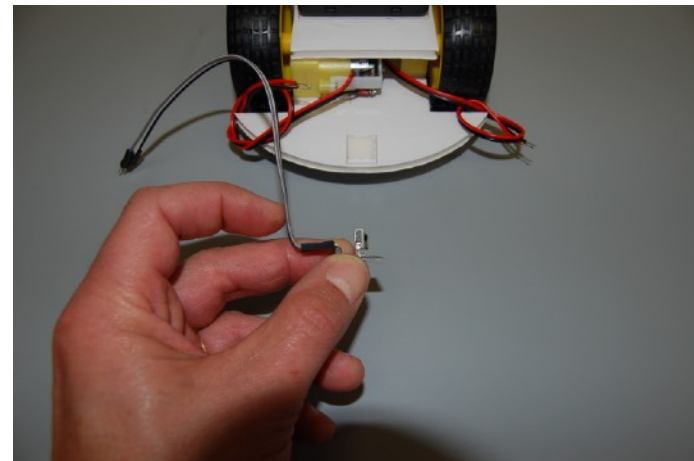
Separate 3 Male-Female Jumper Wires.



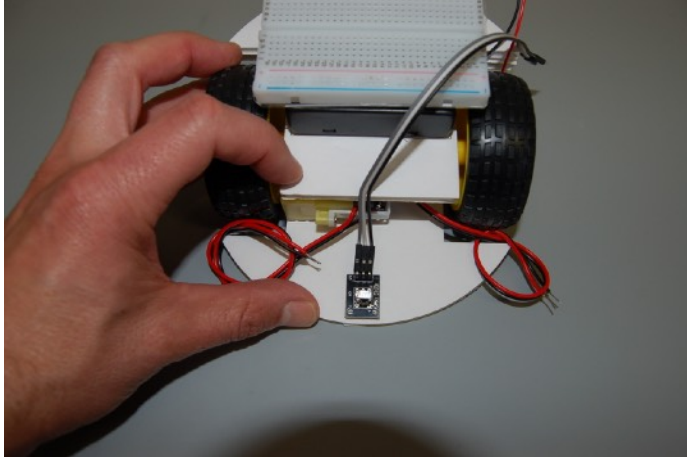
Attach wires to IR Receiver Module.



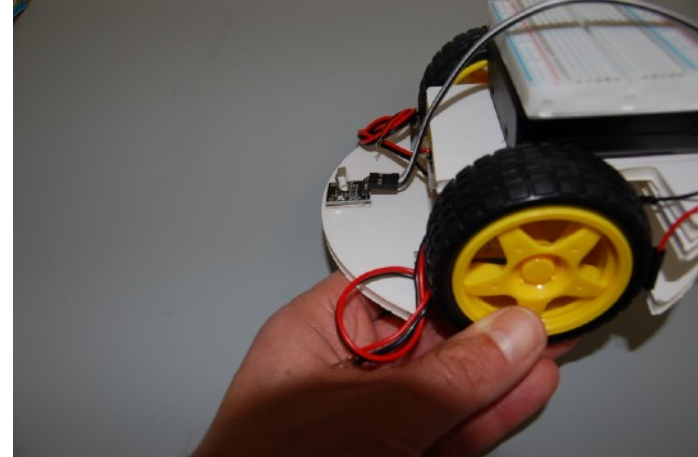
Remove tape covering from IR Receiver Module mounting location.



Gently bend the wires up.

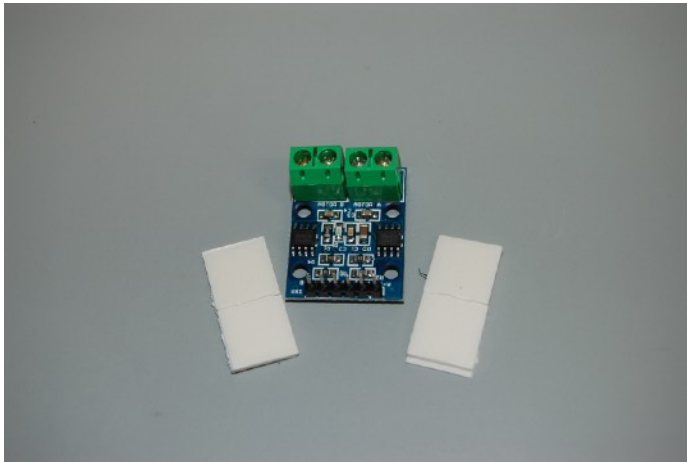


Align the IR Receiver Module as shown and gently press into place.

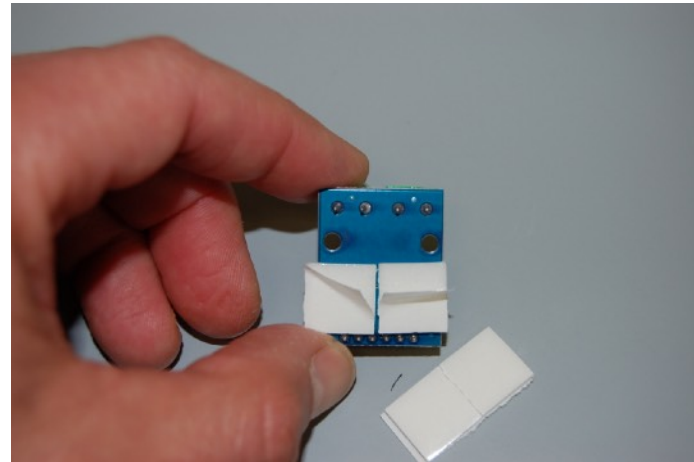


Receiver Ready!

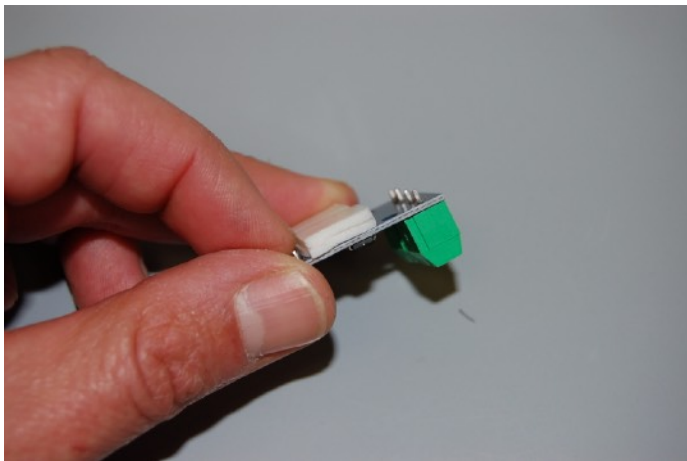
## Step 13: Motor Driver



Find Motor Driver and 4 tape squares.



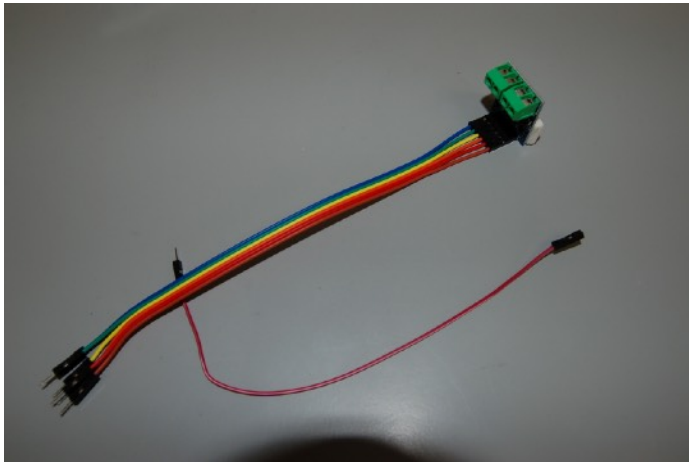
Attach 2 tape squares to the back of the Motor Driver closest to the row of 6 pins. The tape may overhang a bit.



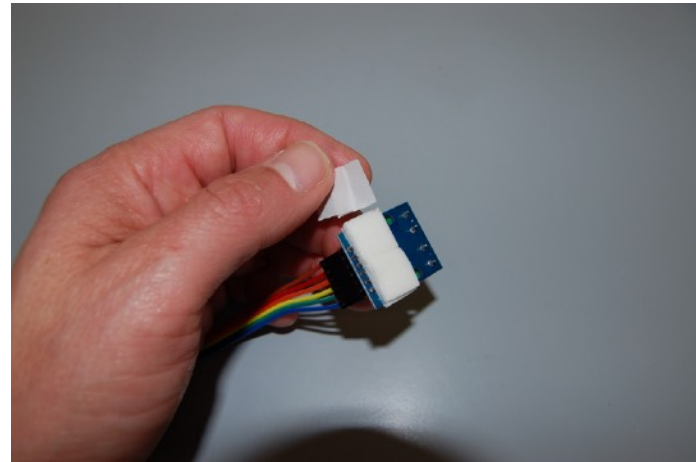
Peel off the tape cover and stack the 2 remaining tape squares on top of the other squares.



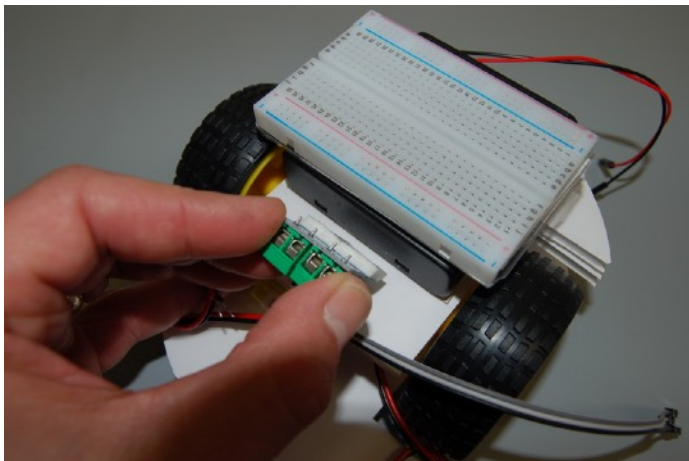
Insert 6 Male-Female wires on to the Motor Driver pins.



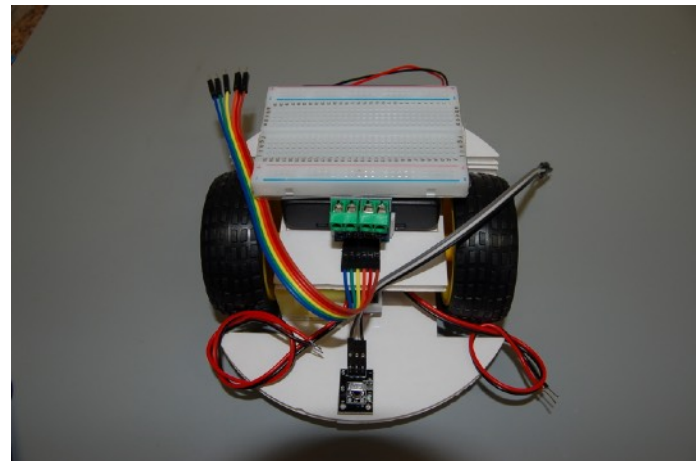
Separate any wires that are not connected.



Remove tape coverings.

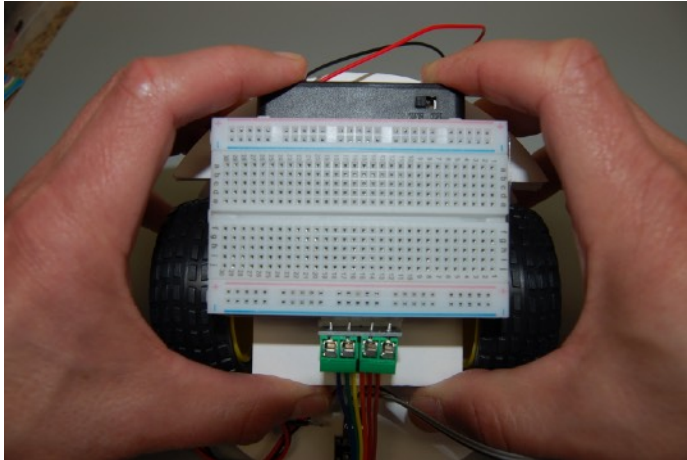


Align the Motor Driver to the Battery Box as shown. Centered left/right, wires down against the foam board.

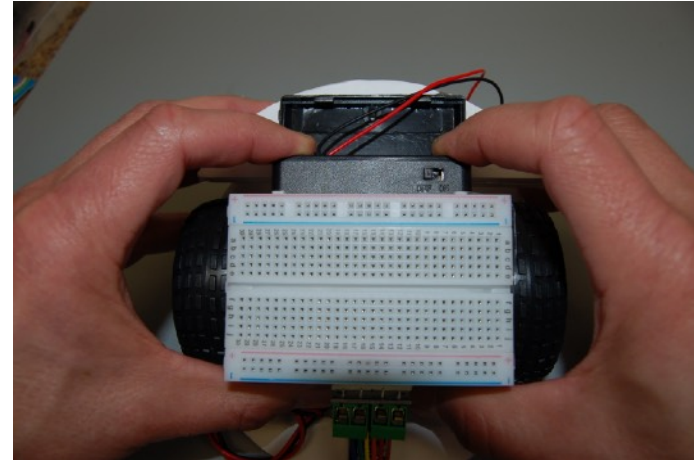


Almost there!

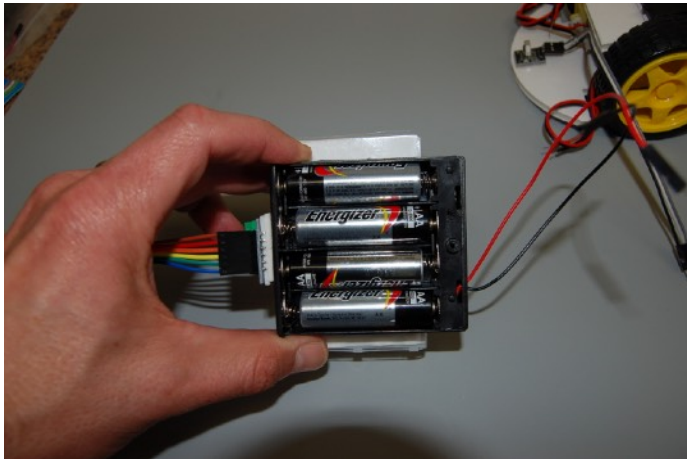
## Step 14: Install Batteries (not included)



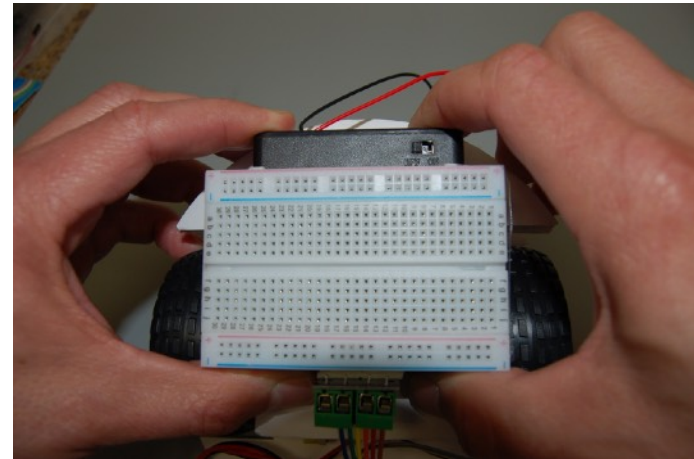
Placing thumbs on edge of Battery Mount foam, fingers at back of of Battery Box, slide the Battery Box lid forward.



Battery Box will open as shown. Make sure the switch is in the "Off" position.

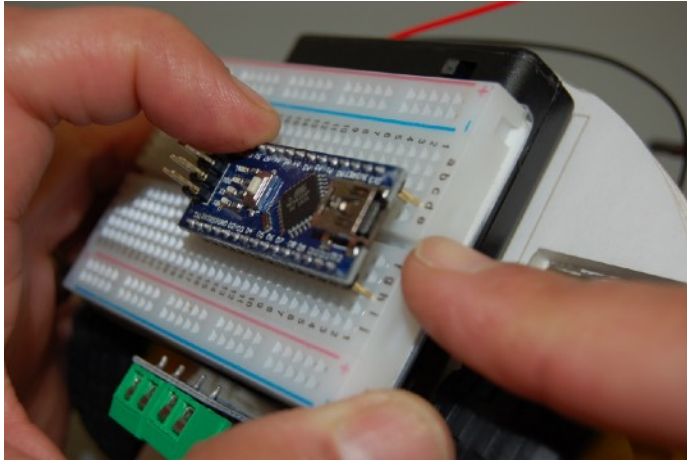


Install 4 AA alkaline batteries (NOT INCLUDED).

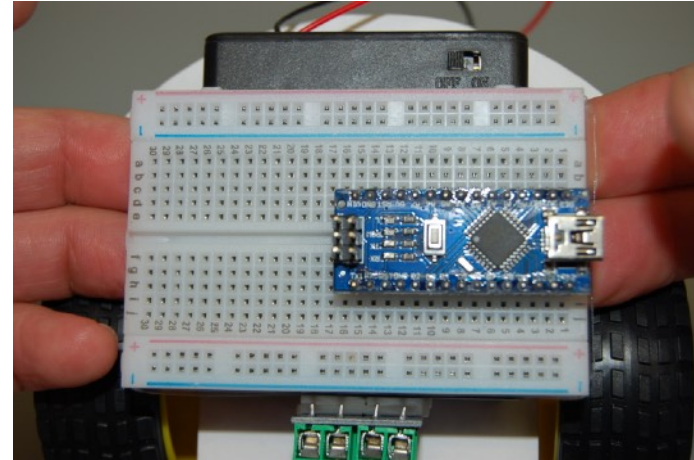


Reverse the process by sliding the Battery Box lid back on the bottom and clicking into position.

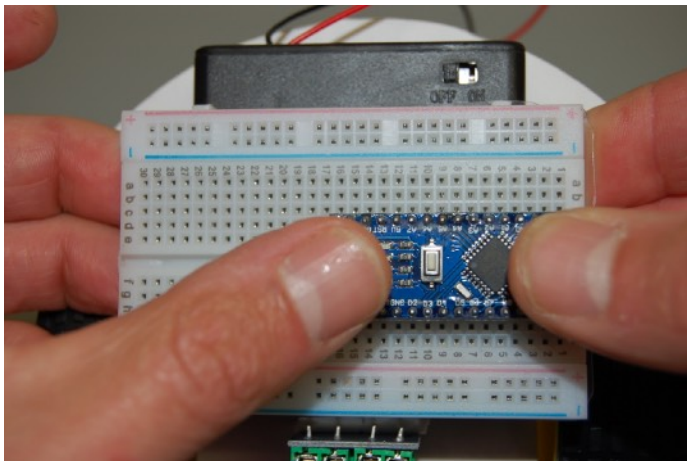
## Step 15: Insert Arduino Nano into Breadboard



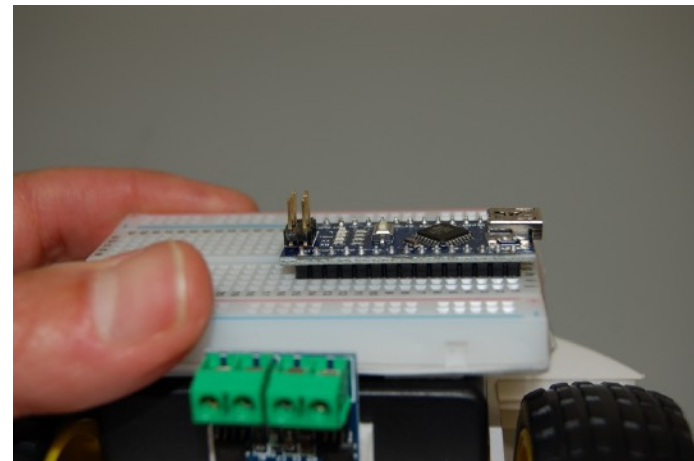
Align Arduino pin D13 with the Breadboard hole d1.  
Align Arduino pin D12 with the Breadboard hole h1.



Place your fingers underneath the Breadboard.



Using your thumbs, apply even pressure to the left and right sides of the Arduino until it fully inserts.



This is how it should look.

## Breadboard Wiring

You will now wire up the rest of the Breadboard.

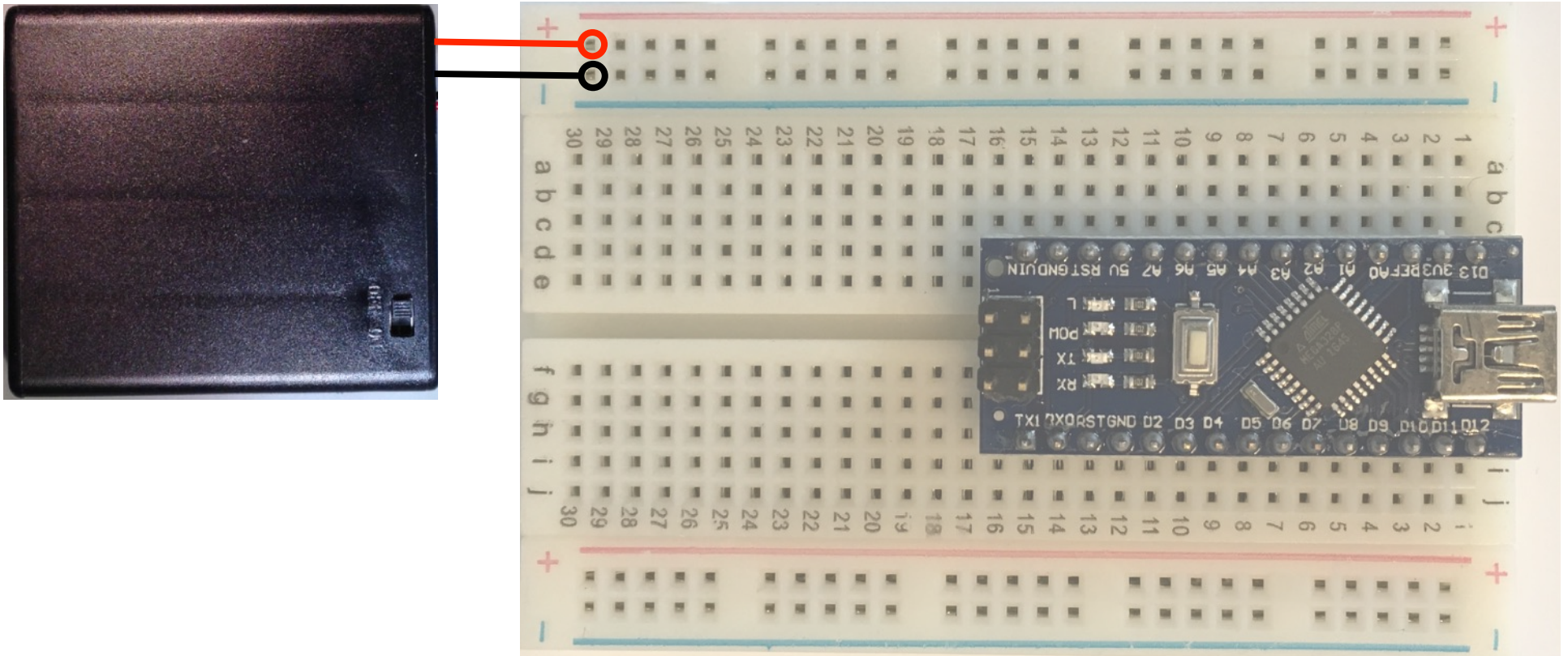
Take your time and double check your work!

Each step will show connections **ONLY FOR THAT STEP**. This should make it easier to see where the wires are going.

At the end of the instructions, you will find a wiring checklist (Attachment A) and a complete wiring diagram (Attachment B).

You may want to refer to both of these as you progress through these steps.

## Step 16: Battery Box



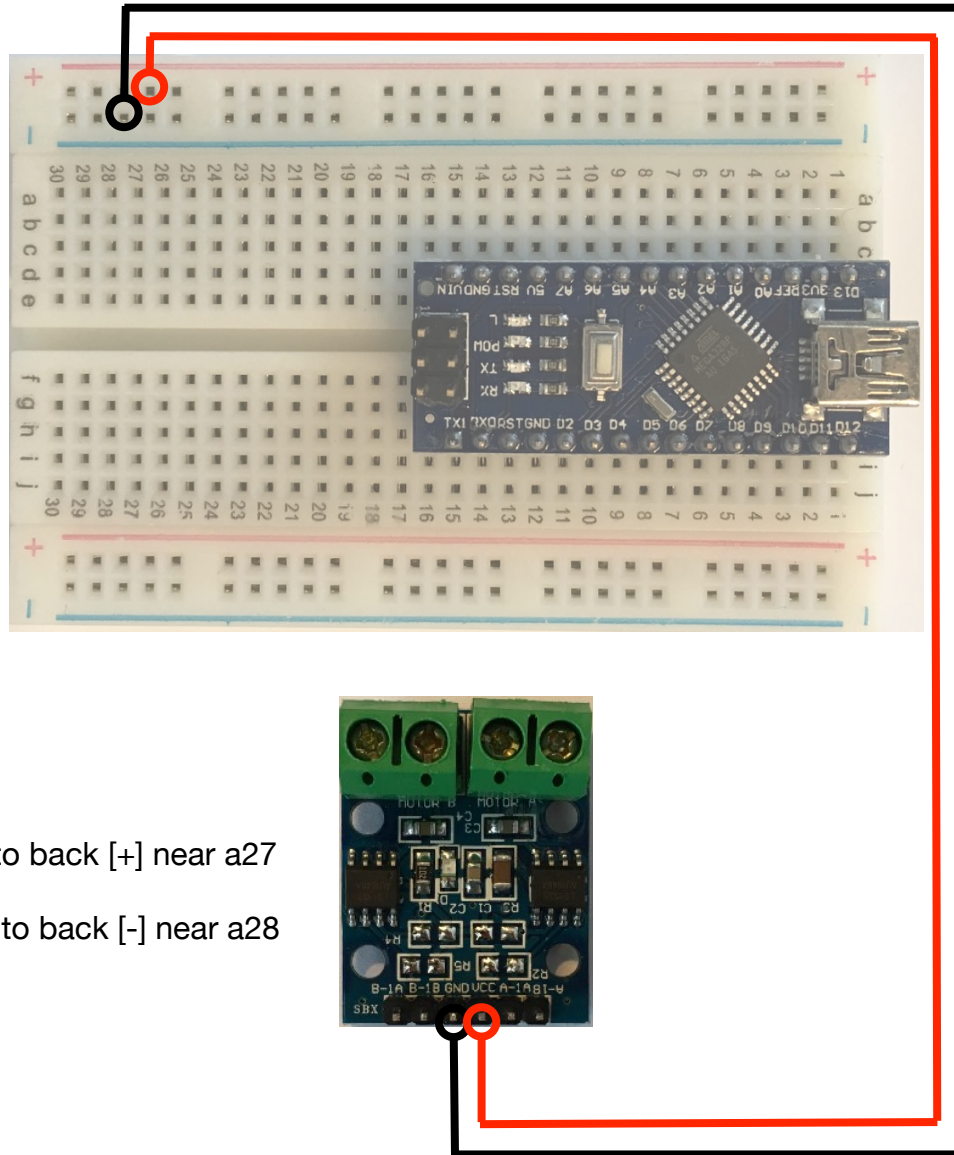
Battery Red Wire to back [+], near a30.

Battery Black Wire to back [-], near a30.



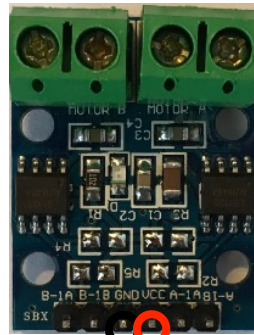


## Step 19: Motor Driver Power

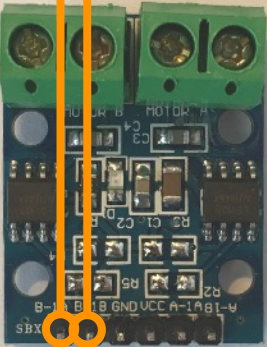
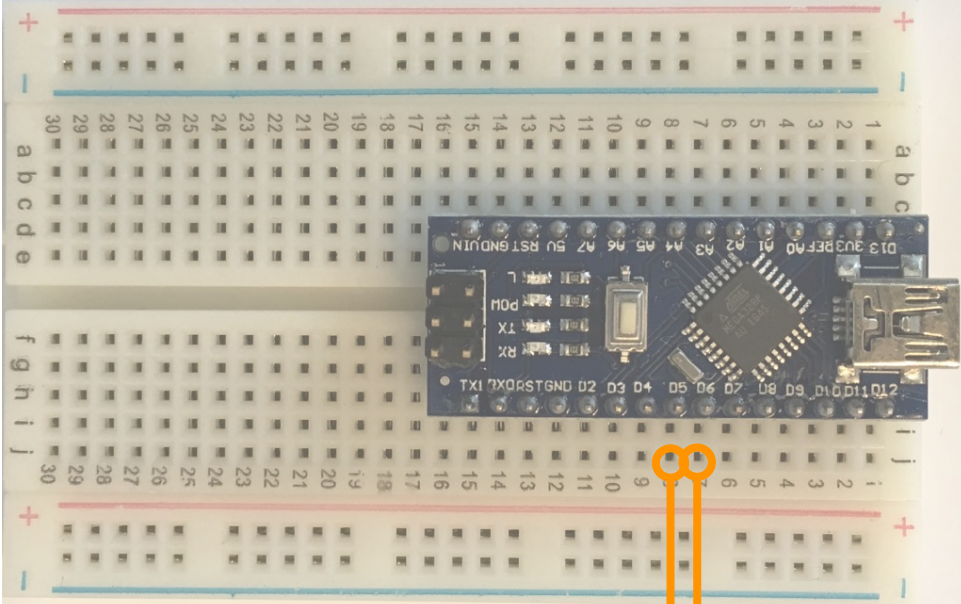


Jumper Wire .. Motor Driver VCC to back [+] near a27

Jumper Wire .. Motor Driver GND to back [-] near a28



# Step 20: Motor Driver Side B

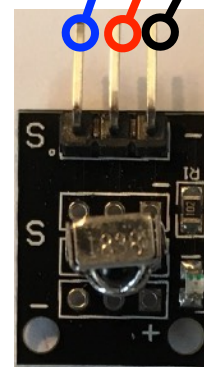
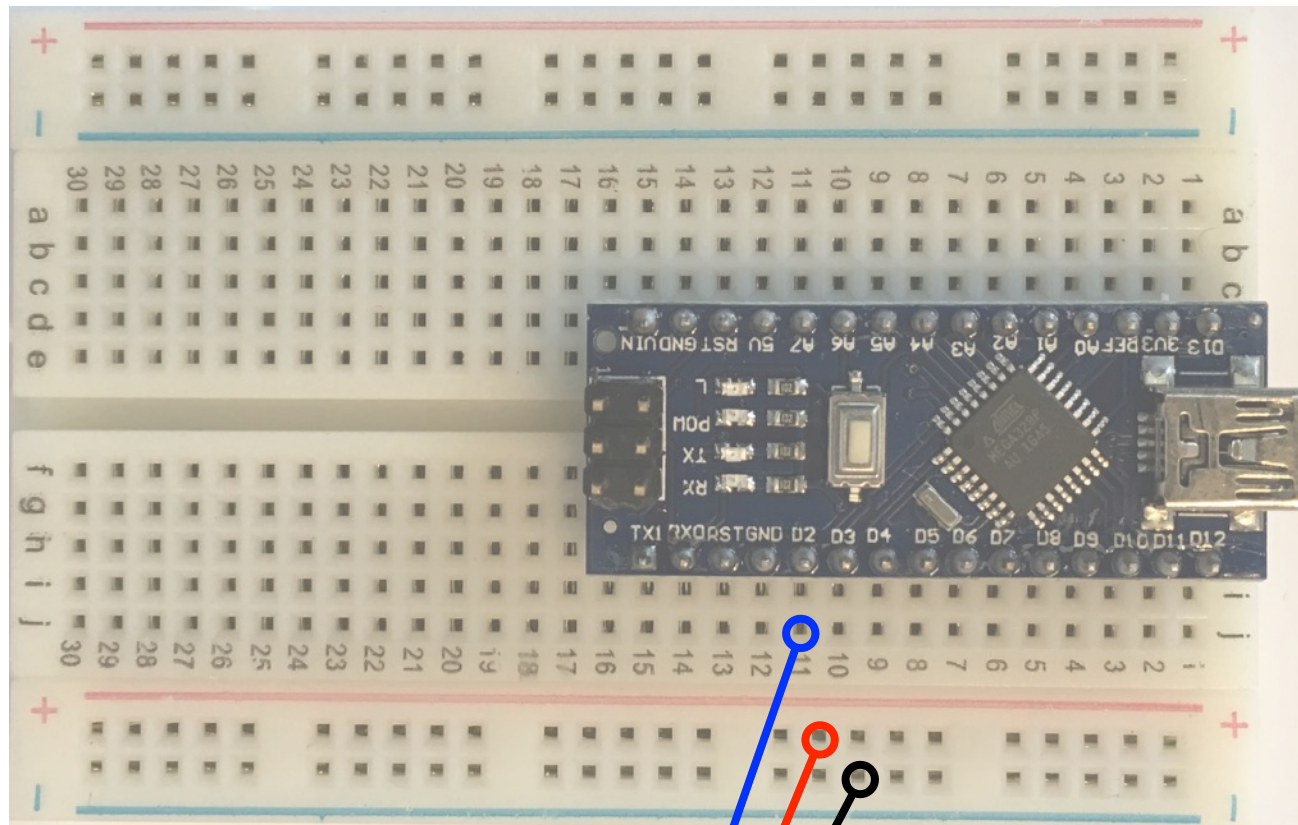


Jumper Wire .. Motor Driver B-IA to j8

Jumper Wire .. Motor Driver B-IB to j7



## Step 22: IR Receiver Module

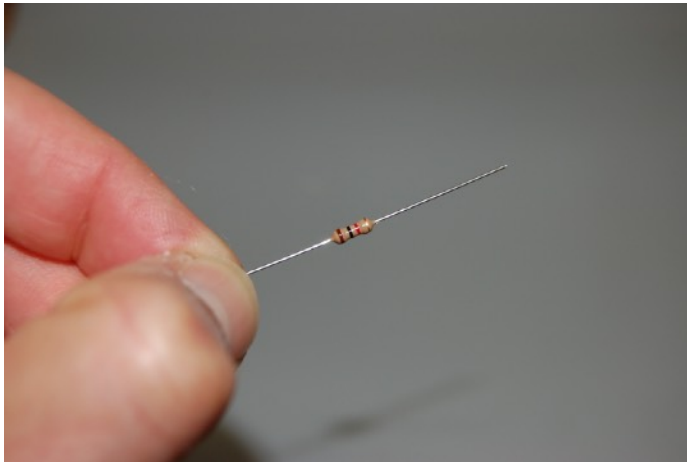


Jumper Wire .. IR Receiver [-] to front [-] near j9

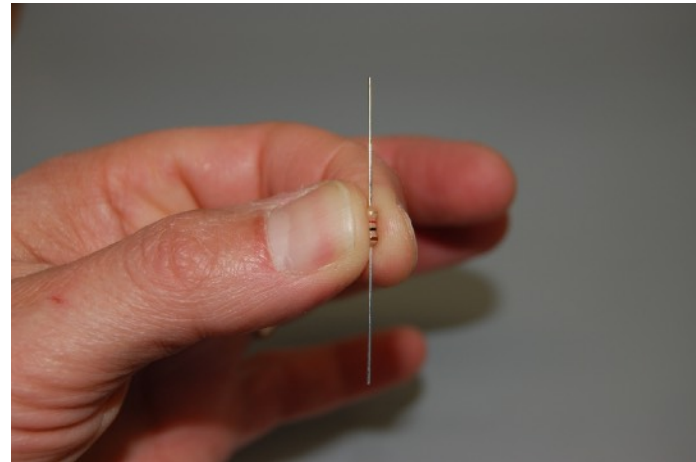
Jumper Wire .. IR Receiver [middle pin] to front [+] near j10

Jumper Wire .. IR Receiver [S] to j11

## Step 23: 1K Resistor Prep



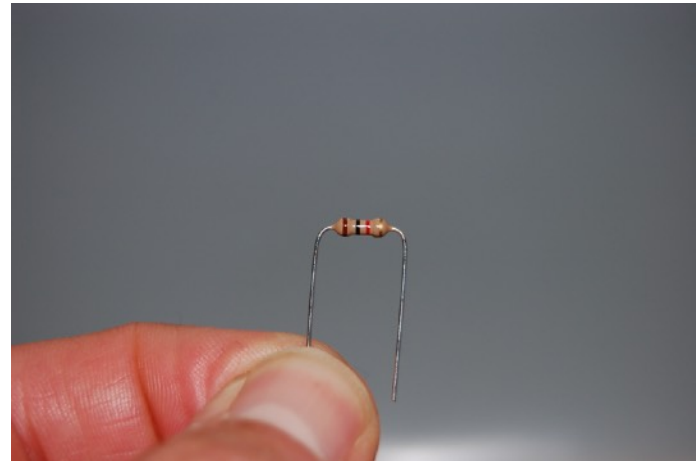
Find the 1K Resistor.



Hold the middle of the 1K Resistor.

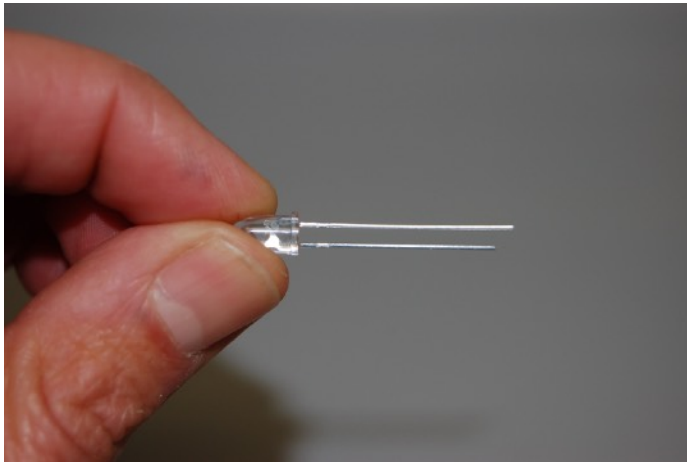


Gently bend the lead wires as shown.

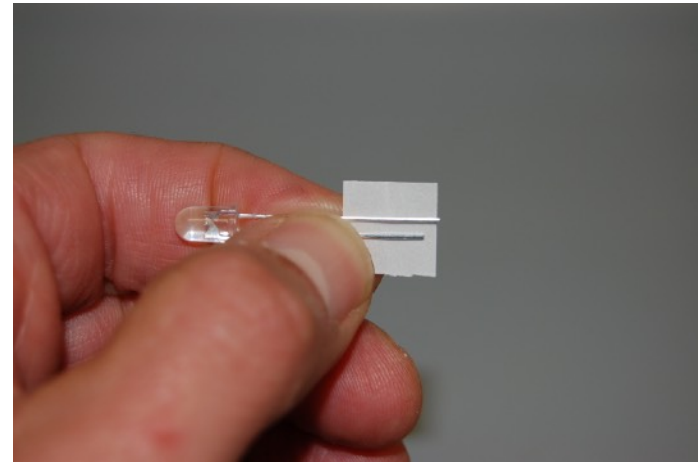


The Resistor should look like this.

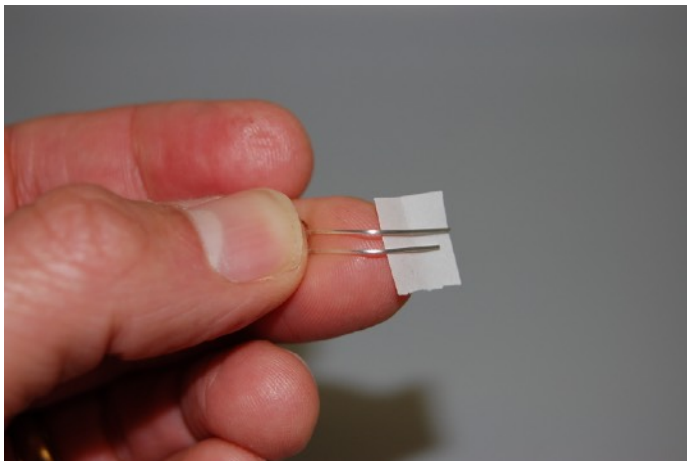
## Step 24: IR LED Prep



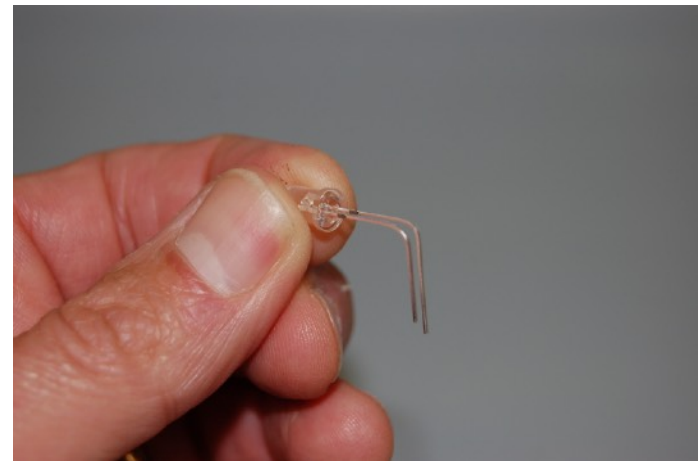
Hold the IR LED with the long lead on top.



Use a tape cover square to measure 1/2" in from the end of the long lead.

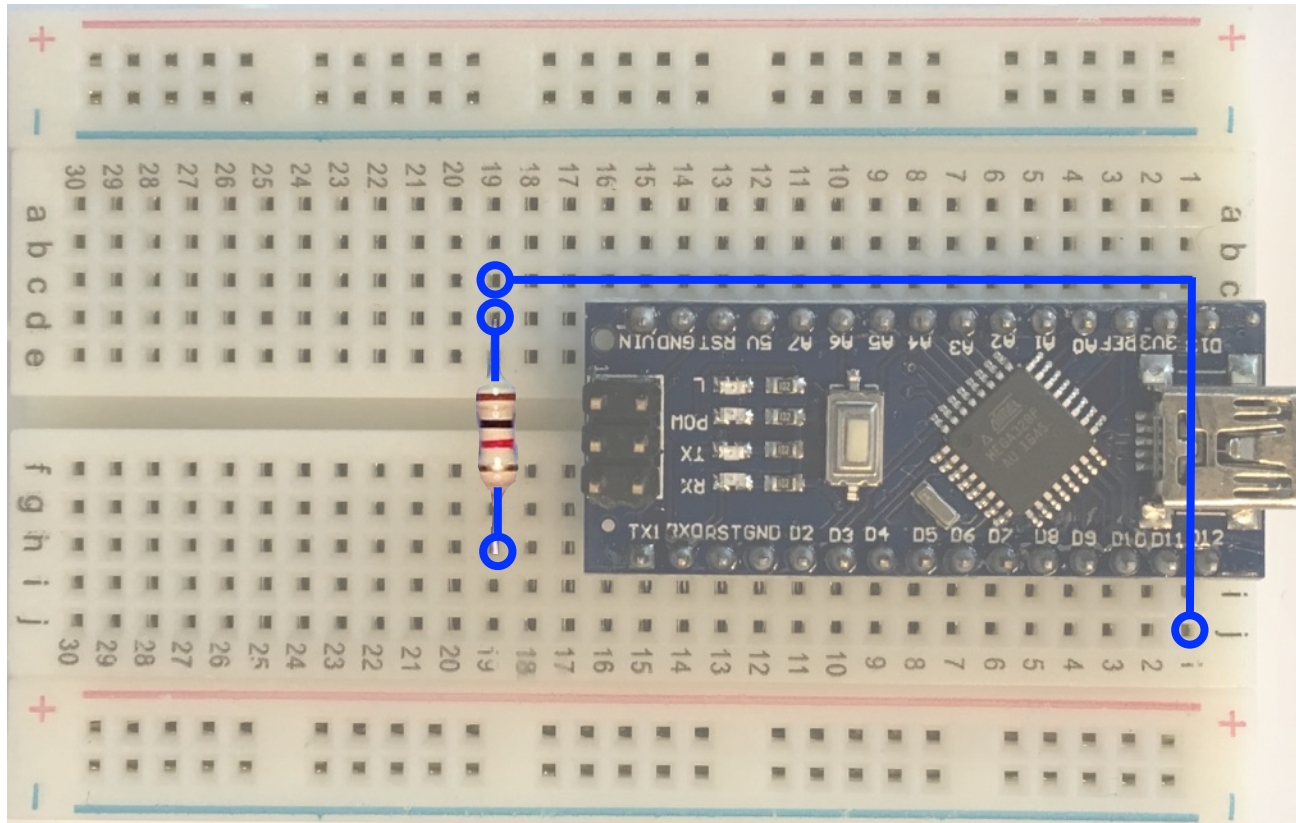


Gently bend both leads away from you to a 90 degree angle at the 1/2" point.



The IR LED should look like this.

## Step 25: 1K Resistor

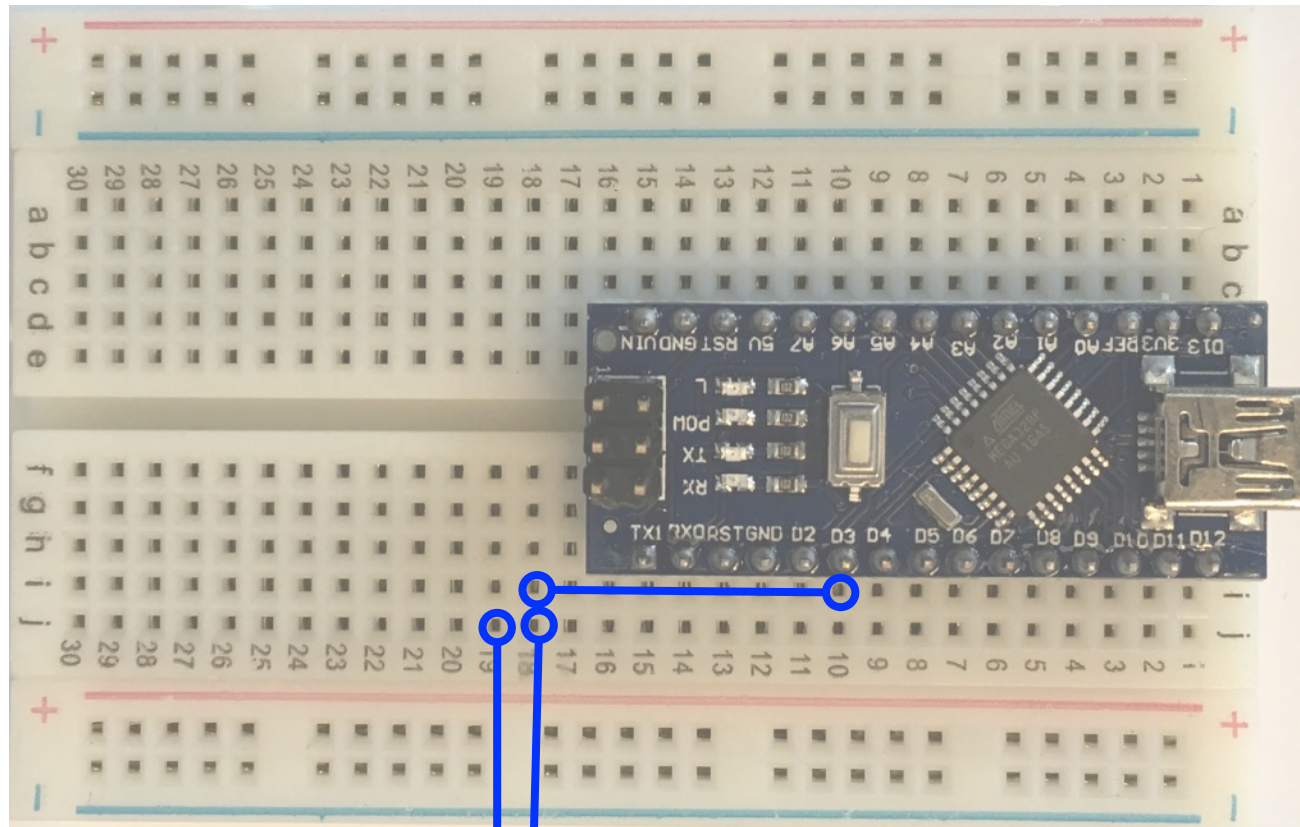


1K Resistor (either lead) to d19

1K Resistor (other lead) to h19

Jumper Wire .. c19 to j1

## Step 26: IR LED



IR LED Long Lead to j19

IR LED Short Lead to j18

Jumper Wire .. i18 to i10



## Step 27: Quick Tests without Motors

Let's do a couple of quick tests. If you don't see the expected results, turn off the power and check your wiring.

Turn the robot's power switch on.

You should see the Arduino's power LED turn on (POW), and the indicator LED (L) flash once, then blink three times.

If your IR Remote has a piece of clear plastic inserted at the battery opening, pull it out.

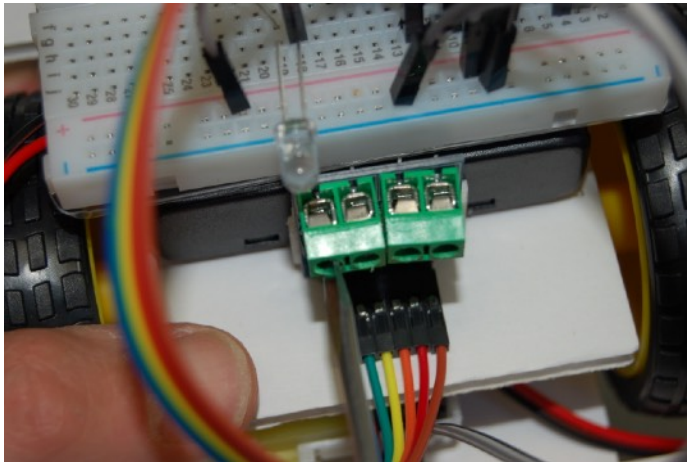
Point the IR Remote at the IR Receiver, then press and hold the "OK" button. The LED on the IR Receiver should blink as long as you hold the button.

Repeatedly press and release the "OK" button. The TX LED on the Arduino should blink once each time you press the button.

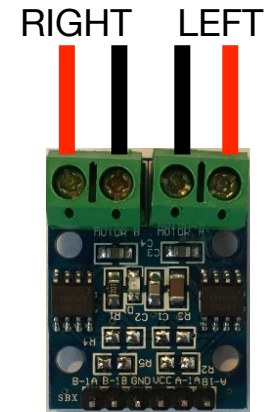
Press and hold the "#" button for a second. With nothing in front of the robot, the IR Receiver LED should be off. Place your hand in front of the robot and the IR Receiver LED should blink.

Turn off the power.

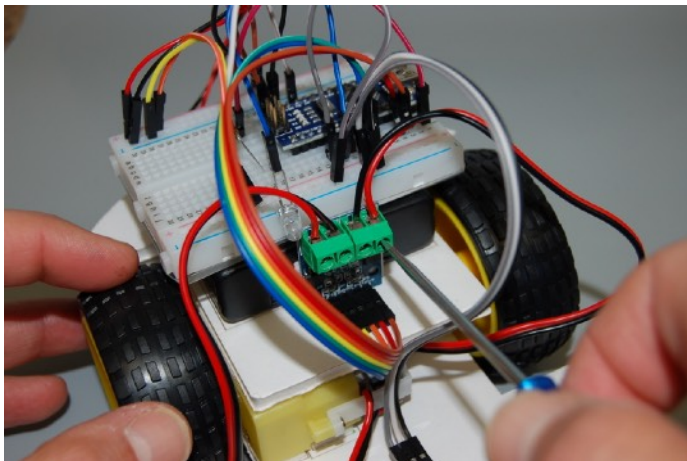
## Step 28: Motor Hook-up



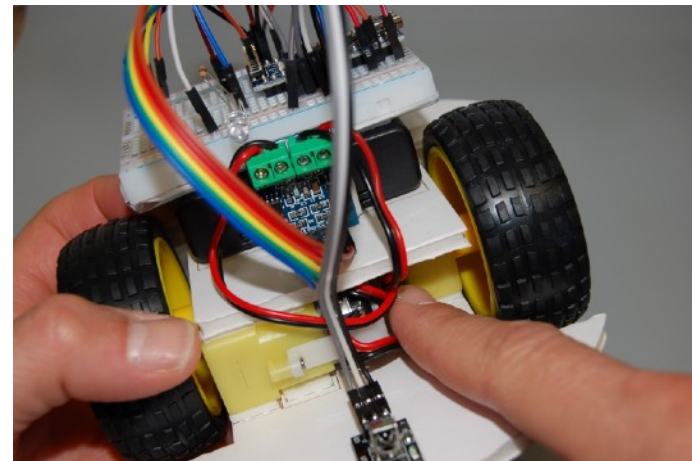
Using the screwdriver, slightly open the 4 Motor Driver connector terminals.



Insert the red and black wires for the Right and Left motors as shown.



Tighten the Motor Driver connector terminals. Make sure the terminals only tighten down on bare wire.



Verify that the motor wires can't easily pull out of the connectors. Tuck the excess wire between the motors.

## It's Alive! Remote Control Mode

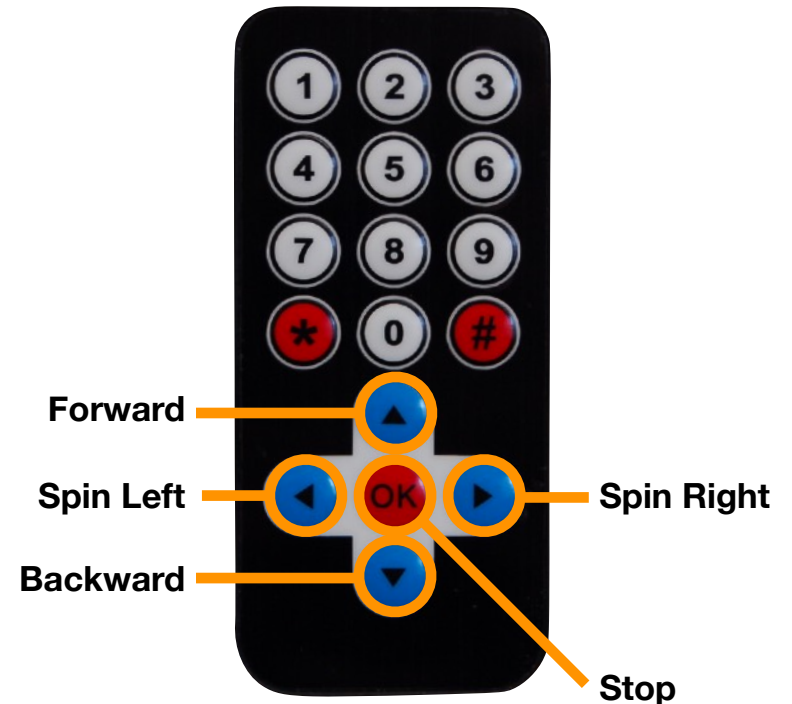
Use the Remote Control to drive your robot!

For any command, you need to press and then release the button (don't hold it down).

The Remote Control works best when you are aiming at the IR Receiver at the front of the robot. If the robot is driving away from you, it may not see your commands. Get closer and in front of the robot, and try again.

Forward/Backward will go for a few seconds, or until interrupted by a new command.

Spin Left and Spin Right will be short spins.



## It's Alive! Autonomous Obstacle Avoidance Mode

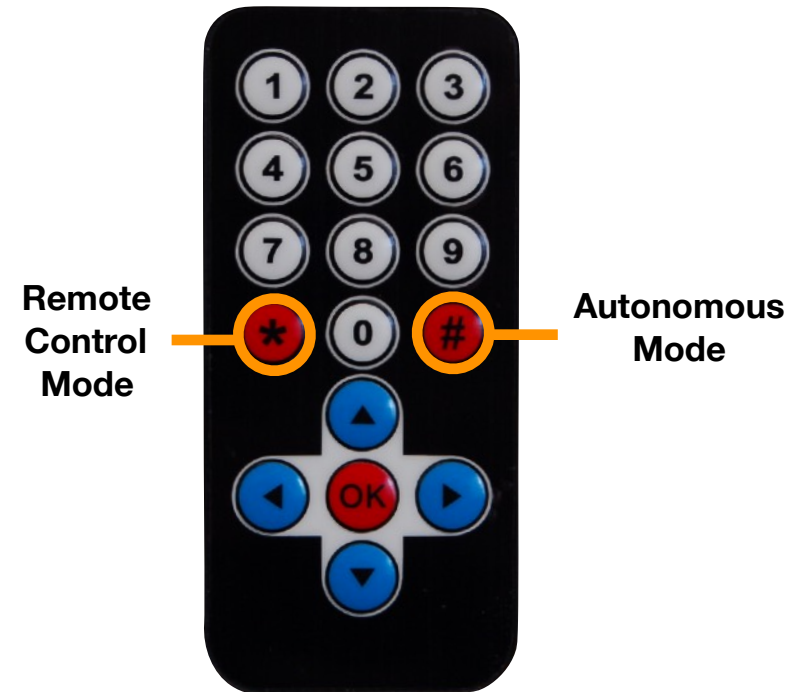
Your robot has a mind of its own!

Press and release the # button to enable Autonomous Mode.

Your robot will wander around, using the IR LED and Receiver to detect avoid obstacles in its way.

Ok, it doesn't see everything, and will eventually get stuck or need your help.

To go back to Remote Control Mode, press and release the \* button.



## Decorate and Experiment!

Now that you've built your robot, go ahead and give it a personality. Add color, googly eyes, stickers, give it a name, use your imagination!

One of the reasons we use foam board to make your robot is to show you how easy it is to build NEW robots. Get some extra tape, cardboard, foam board, scissors, and build robots of your own design. You can always cut out a new 2020 Bot by printing the templates (Attachments D and E).

The electronics and motors used on the robot are very common and can be used for all sorts of projects. The web is full of instructions and tutorials to help you learn about Arduino programming, electronics, mechanics, and robotics. Check out our website for some recommended links.

## Attachment A: Wiring Checklist

Insert Arduino into Breadboard:

- Arduino D13 pin -> Breadboard [d1]
- Arduino D12 pin -> Breadboard [h1]

Battery Connections:

- Battery Red Wire (Battery 6V) -> Breadboard [+] Row, near [a30]
- Battery Black Wire (Battery GND) -> Breadboard [-] Row, near [a30]
- Jumper Wire .. Breadboard [a14] (Arduino GND) -> Breadboard - Back Row (Battery GND) near [a14]
- Jumper Wire .. Breadboard [a15] (Arduino VIN) -> Breadboard + Back Row (Battery 6V) near [a15]

Motor Driver Connections:

- Jumper Wire .. Motor Driver VCC -> Breadboard + Back Row (Battery 6V) near [a28]
- Jumper Wire .. Motor Driver GND -> Breadboard - Back Row (Battery GND) near [a28]
- Jumper Wire .. Motor Driver B-IA -> Breadboard [j8] (Arduino D5)
- Jumper Wire .. Motor Driver B-IB -> Breadboard [j7] (Arduino D6)
- Jumper Wire .. Motor Driver A-IA -> Breadboard [j3] (Arduino D10)
- Jumper Wire .. Motor Driver A-IB -> Breadboard [j4] (Arduino D9)

IR Receiver Connections:

- Jumper Wire .. Breadboard [b12] (Arduino 5V) -> Breadboard + Front Row near [j21]
- Jumper Wire .. Breadboard [j12] (Arduino GND) -> Breadboard - Front Row near [j13]
- Jumper Wire .. IR Receiver - (IR GND) -> Breadboard - Front Row near [j9]
- Jumper Wire .. IR Receiver Middle (IR 5V) -> Breadboard + Front Row near [j10]
- Jumper Wire .. IR S (IR Signal) -> Breadboard [j11] (Arduino D2)

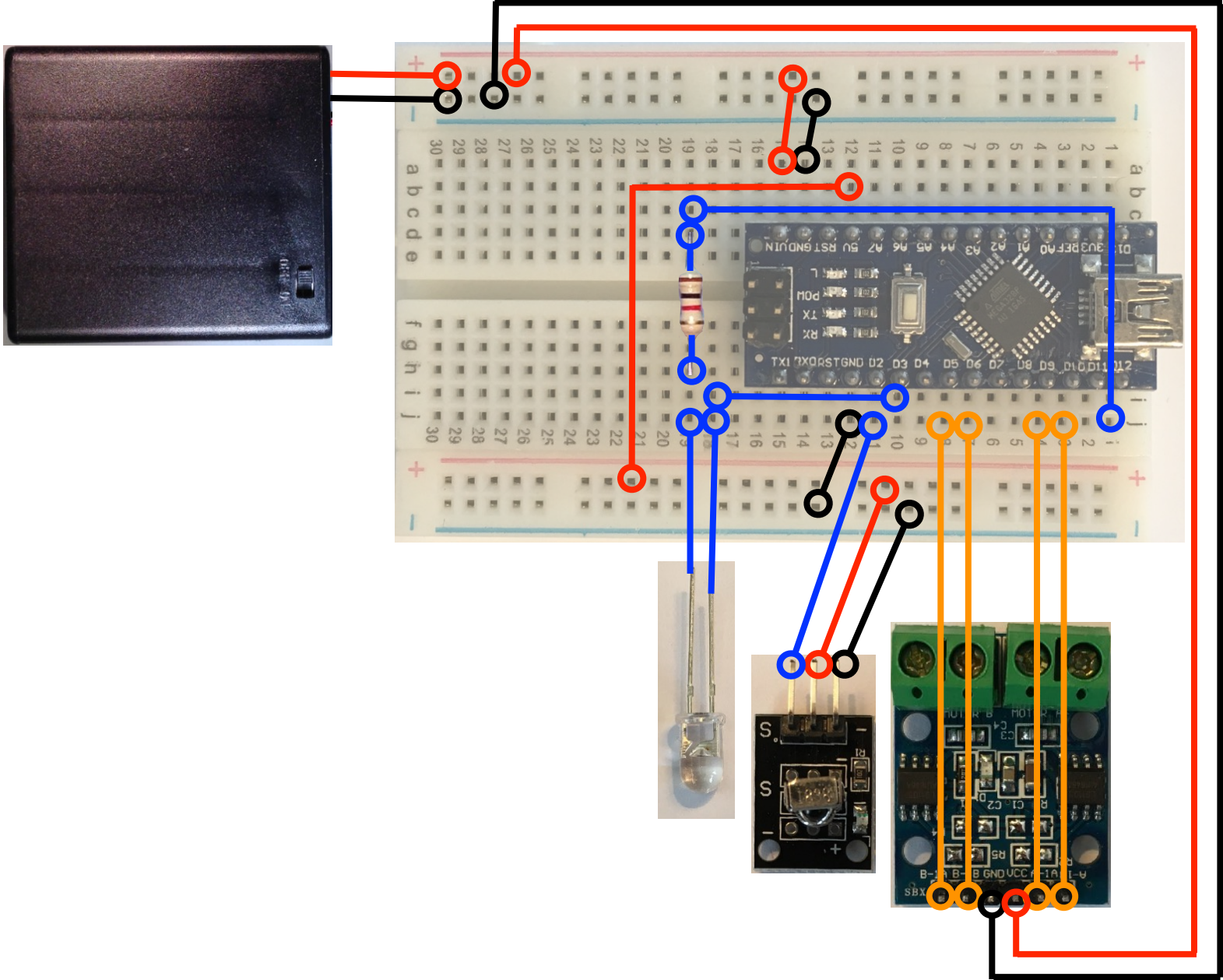
IR LED and Resistor Connections:

- Resistor -> Breadboard [d19]
- Resistor -> Breadboard [h19]
- LED Long Lead -> Breadboard [j19] (Resistor)
- LED Short Lead -> Breadboard [j18]
- Jumper Wire .. Breadboard [c19] (Resistor) -> Breadboard [j1] (Arduino D12)
- Jumper Wire .. Breadboard [i18] (LED Short Lead) -> Breadboard [i10] (Arduino D3)

Wires may need to be swapped if a motor runs in the wrong direction

- Left Motor -> Motor B Screw Terminal
- Left Motor -> Motor B Screw Terminal
- Right Motor -> Motor A Screw Terminal
- Right Motor -> Motor A Screw Terminal

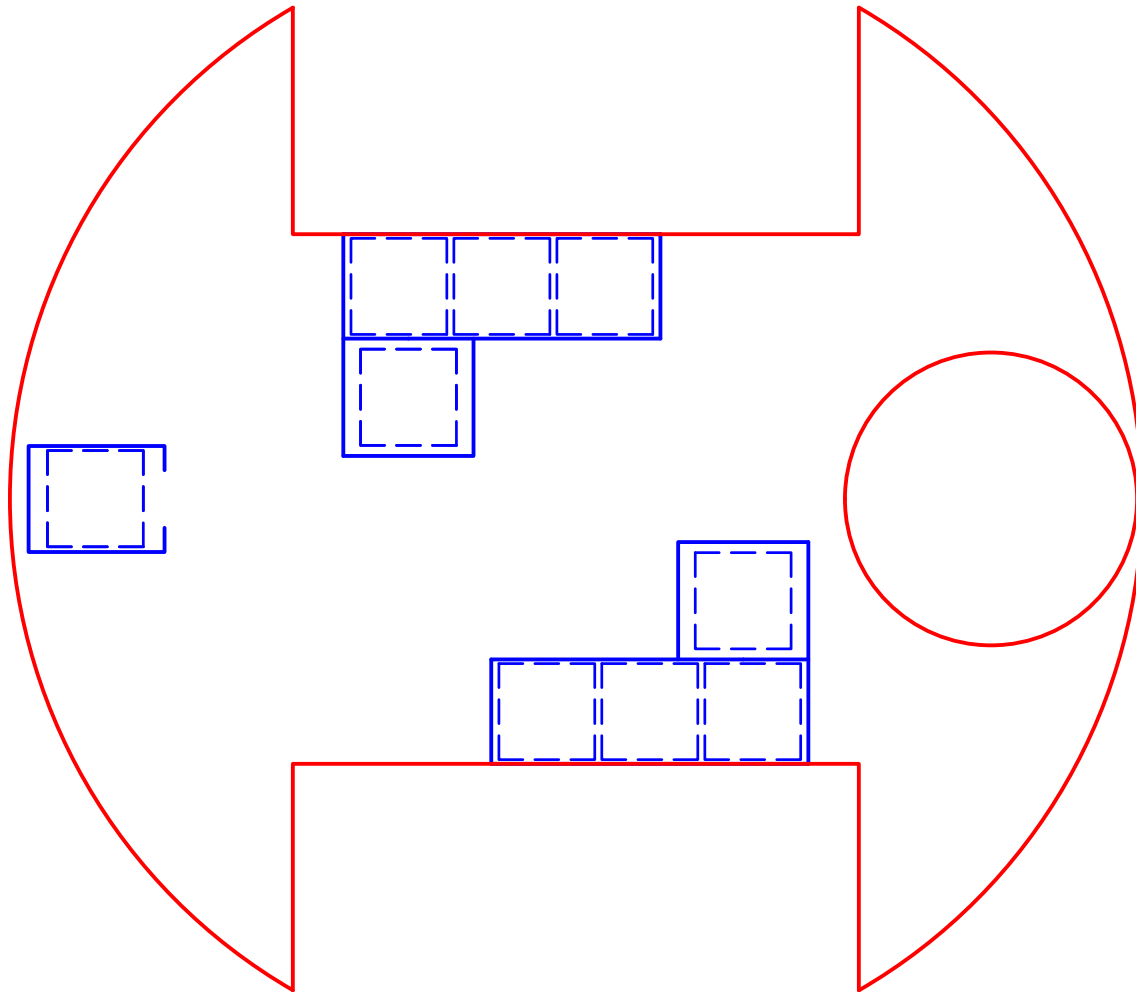
# Attachment B: Wiring Diagram



## Attachment C: Arduino Pin Mapping

<b>Pin</b>	<b>Type</b>	<b>Description</b>
D2	Input	IR Receiver Input
D3	Output	IR LED Frequency Output
D5	Output	Right Motor Output B
D6	Output	Right Motor Output A
D9	Output	Left Motor Output B
D10	Output	Left Motor Output A
D12	Output	IR LED Data Output

# Attachment D: Base Plate Template



# Attachment E: Battery Mound and Spacer Template

