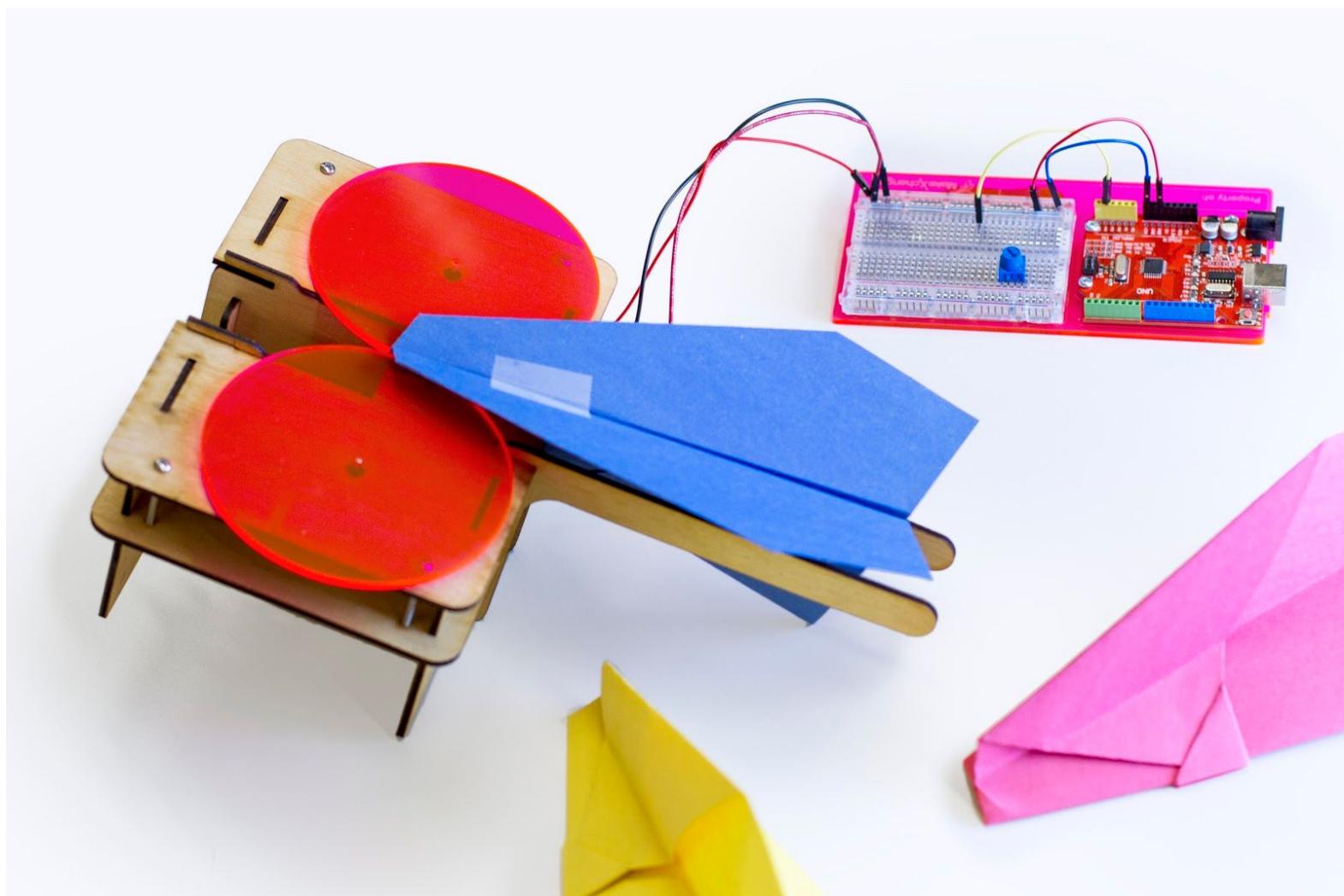




# BUILD YOUR OWN PROGRAMMABLE PAPER AIRPLANE LAUNCHER



ASSEMBLY INSTRUCTION MANUAL

[www.makexchange.com](http://www.makexchange.com)

## WARNINGS:



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⚠️ **CAUTION:** Never launch airplanes in the direction of other people. Make sure the launch area is free of people before using.

⚠️ **CAUTION:** Use protective eyewear when possible during operation.

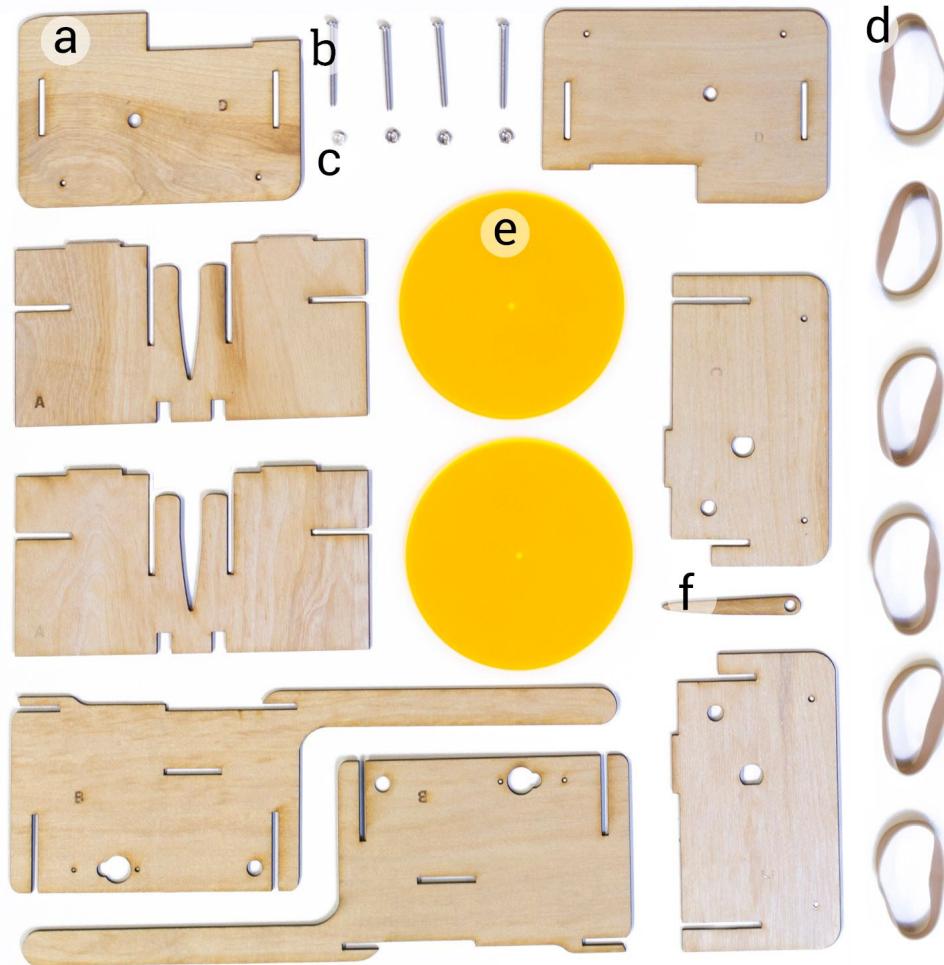
⚠️ **CAUTION:** Choking hazard. This kit contains small pieces that young children can choke on. Keep it and all parts away from young children. It's not appropriate for kids ages 3 and under. Ages 10 and up.

⚠️ **CAUTION:** Not a toy. Use caution when operating. Adult supervision is recommended for kids under 15 years of age. **Keep fingers, loose clothing, and long hair away from the motors and wheel assemblies.**

Reach out to us with any questions or comments at:  
[support@makexchange.com](mailto:support@makexchange.com)

# PARTS LIST:

## Parts From Your Paper Airplane Kit



The following parts are included in your Paper Airplane Launcher Kit.

**NOTE:**

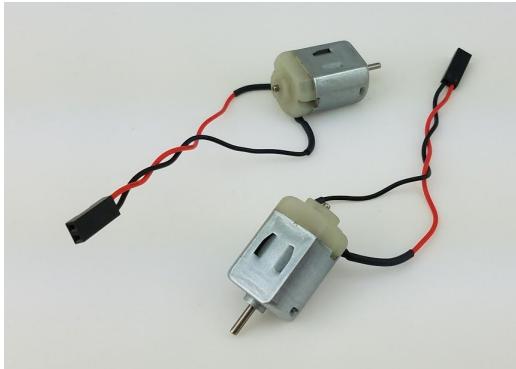
- Life's like a box of chocolates. The color of acrylic used for the wheels varys from kit to kit.
- Parts are made on a laser cutter and may have light soot and/ or scorching on them.

- a. 8 Laser Cut wooden panels
- b. 4 Fastening screws
- c. 4 Nuts

- d. 6 Rubber Bands
- e. 2 Acrylic Wheels
- f. 1 Acrylic Trajectory Cam

## Parts You'll Need From Your Invention Lab

The following parts from your invention lab will be needed to complete this project.



### 2 x DC Motors:

Note: This instruction manual was first produced using an older model of DC motors. We have since upgraded the DC motors in the Invention lab. At the time of this printing, the motors above are the motors to use for these projects.

These motors have female pins you can plug your DuPont cables easily into.



### 1 x NPN Transistor

This will control the launcher's speed.



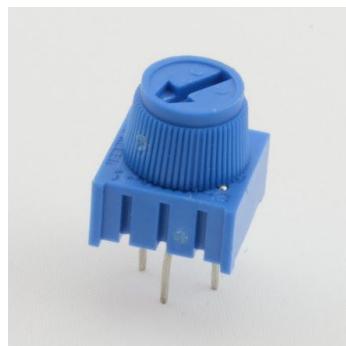
### The Battery Power Adapter (6 x AA Batteries)

You'll need this to power the launcher. It takes 6 AA batteries (not included).



### 1 x Digital Servo Motor

This will move a cam that sets the trajectory angle of the launcher.



### 2 x Potentiometers

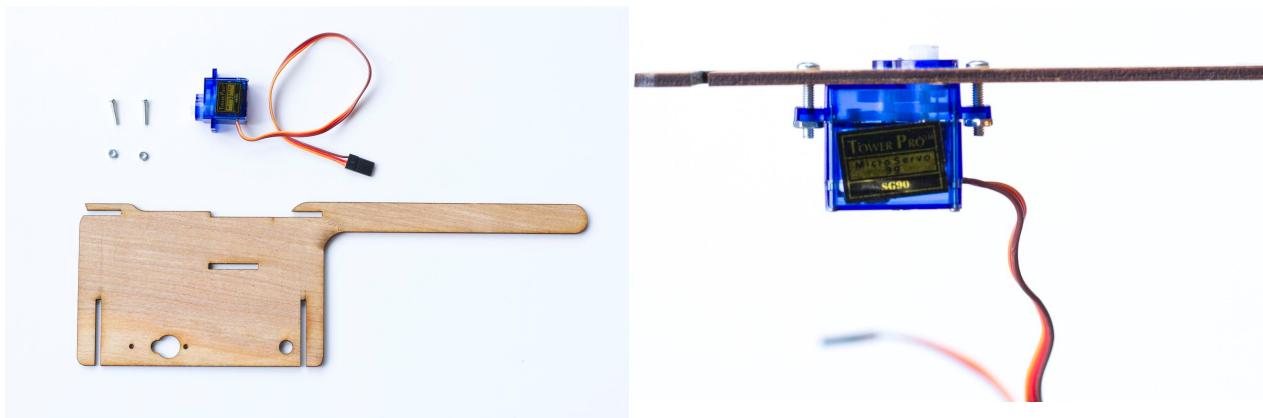
You will use these to change the speed and pitch of the launcher.

# LAUNCHER ASSEMBLY INSTRUCTIONS

For full video assembly instructions please visit: [www.makexchange.com](http://www.makexchange.com)

## 1. Attach the servo motor through the opening in the Guide Panel.

Use the servo and the two servo screws and matching nuts from your MakeXchange Invention Lab, Inventing With Electronics For Beginners Volume 1.



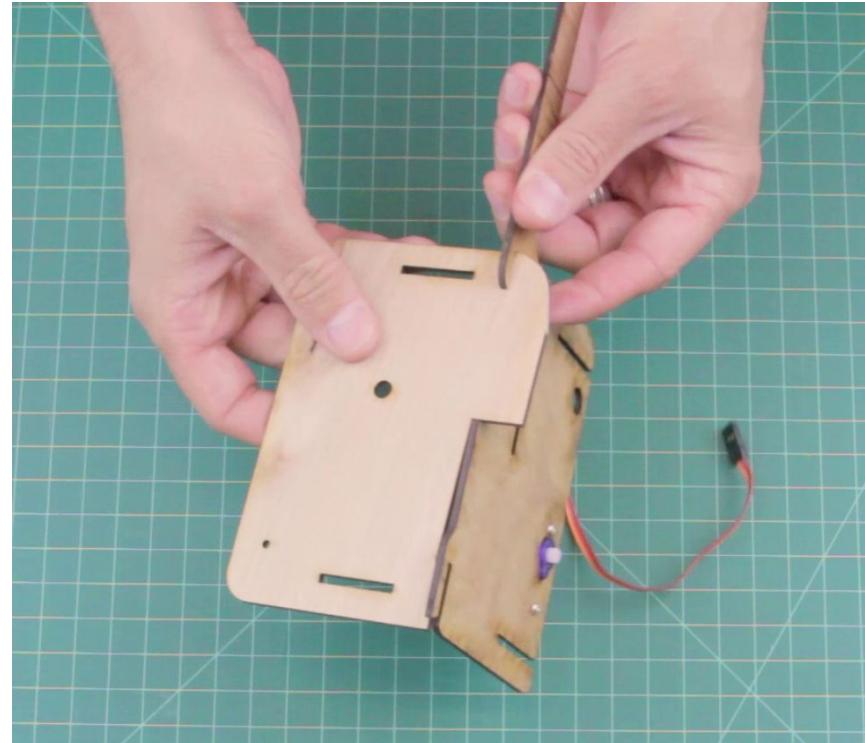
Servo Screws and Nuts



Here is a close-up of the servo screws and nuts. These were included in the Invention Lab. Replacements can be ordered at [www.makexchange.com](http://www.makexchange.com).

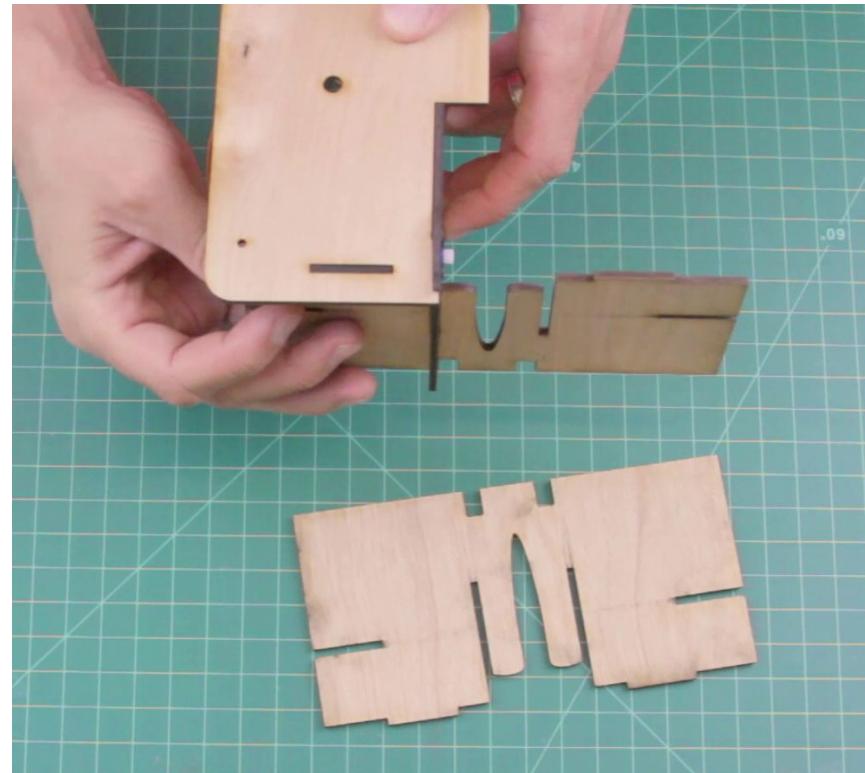
**2. Slide the Top Panel  
into the top slots of the  
Guide Panel.**

Make sure the white tip of  
the servo motor is facing  
inside.

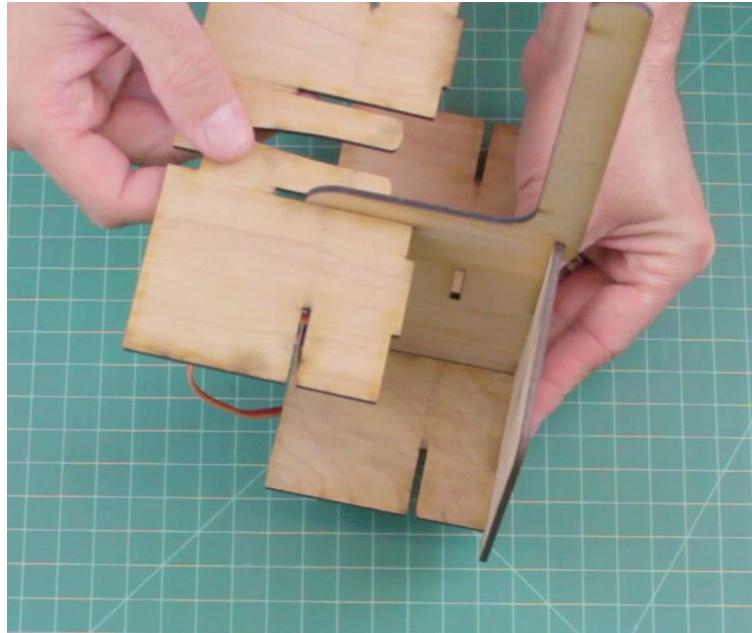


**3. Slide one Front Panel  
into the front of the Guide  
Panel.**

The notch on top of the  
Front Panel should slide  
flush into opening of the  
Top Panel.

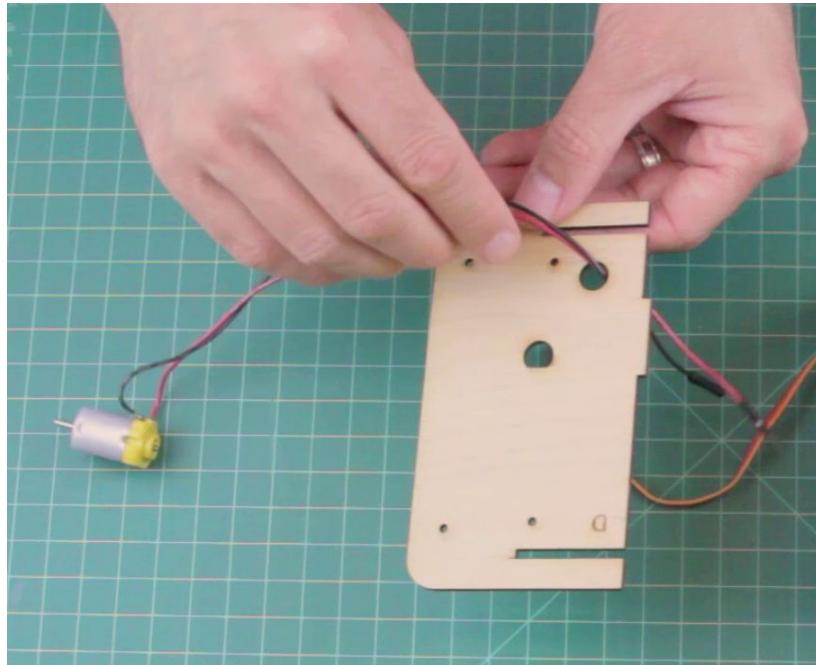


**4. Slide the other Front Panel into the back of the Guide Panel.**



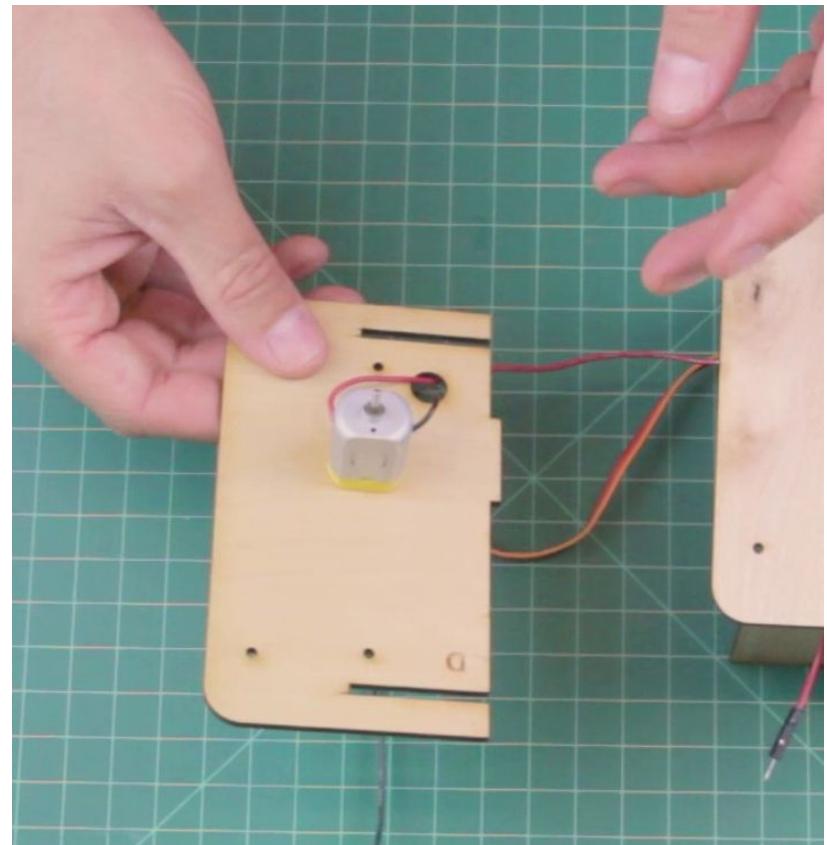
**5. Run the DC Motor wires through the circular hole in the Middle Panel.**

**NOTE:** The motors in your invention lab may have different wiring. If so, use your longer dupont cables to connect the motors to the breadboard. Male/Female dupont cables can be used as extension cords where needed.



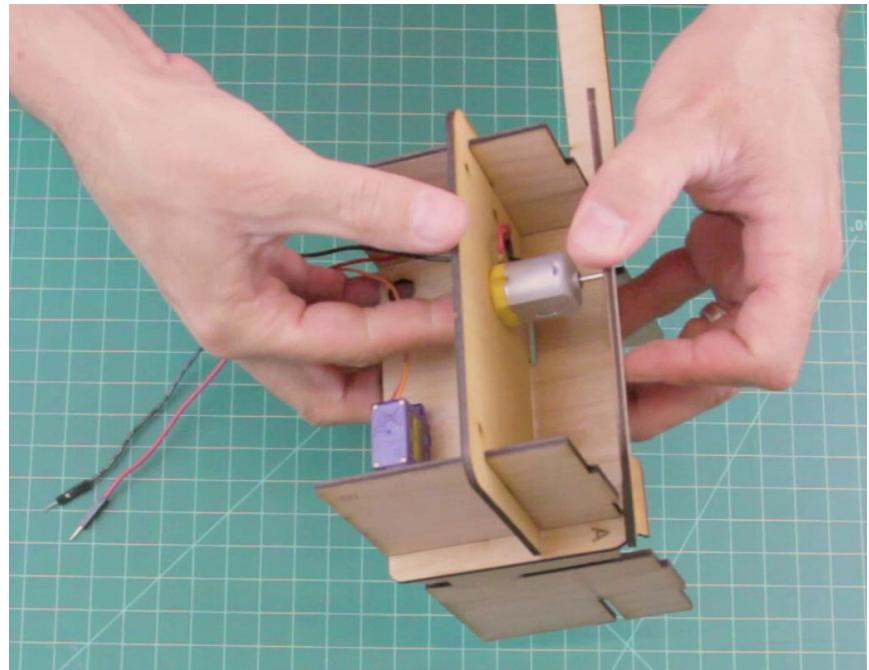
**6. Insert DC motor into the Middle panel.**

It should fit snugly in place.



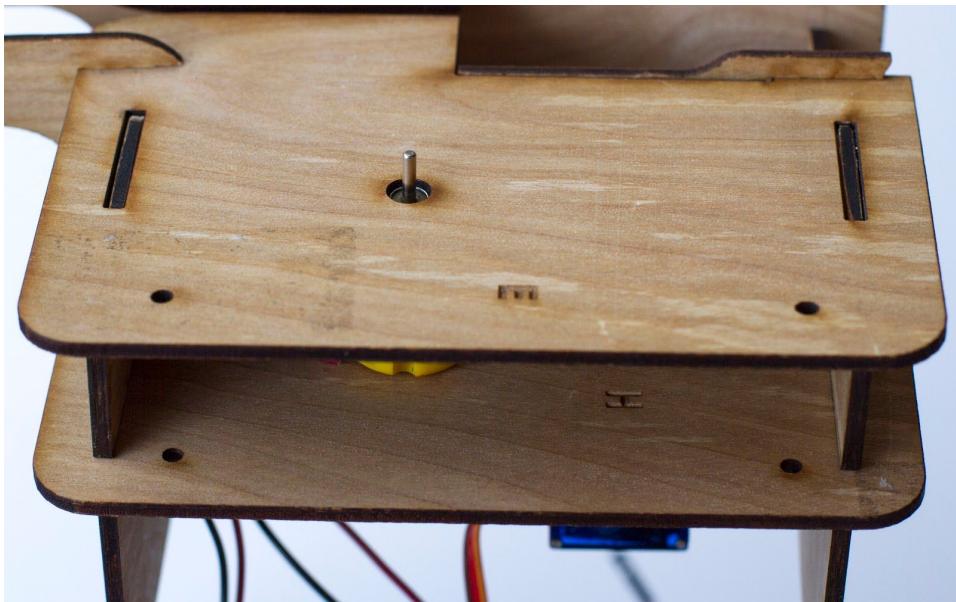
**7. Slide the Middle Panel into the the Front Panels, lifting the Top Panel at an angle so that the motor can slide into position.**

Make sure the notch of the Middle Panel is seated flush with the Guide Panel.

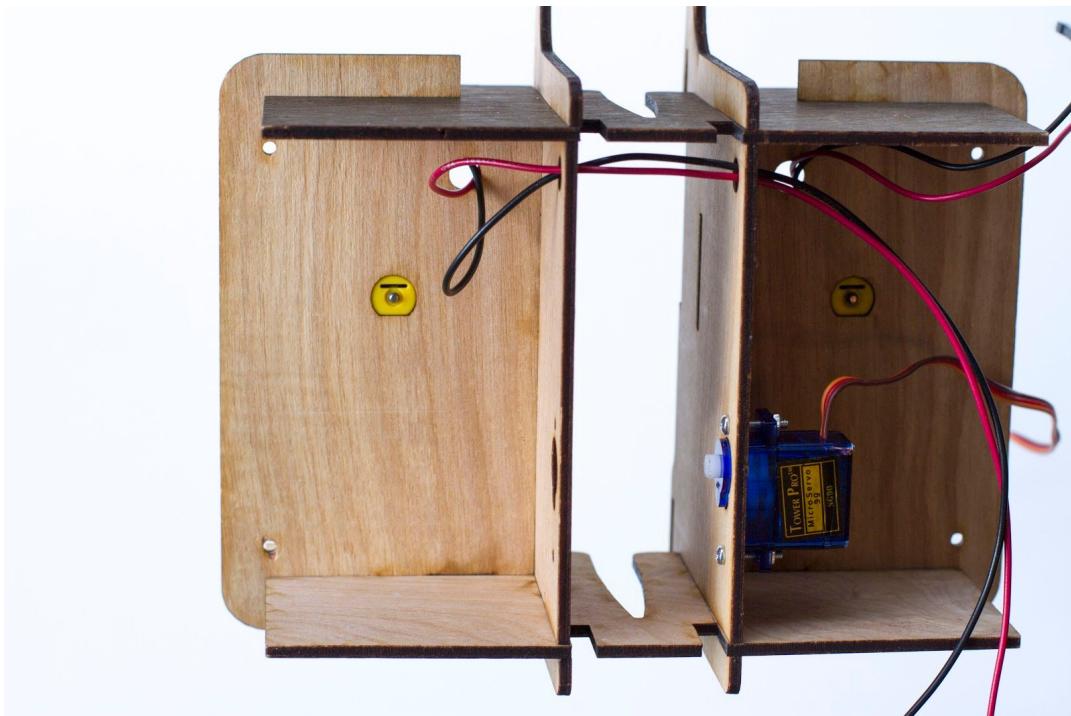


When the top of the motor is aligned it will click into place.

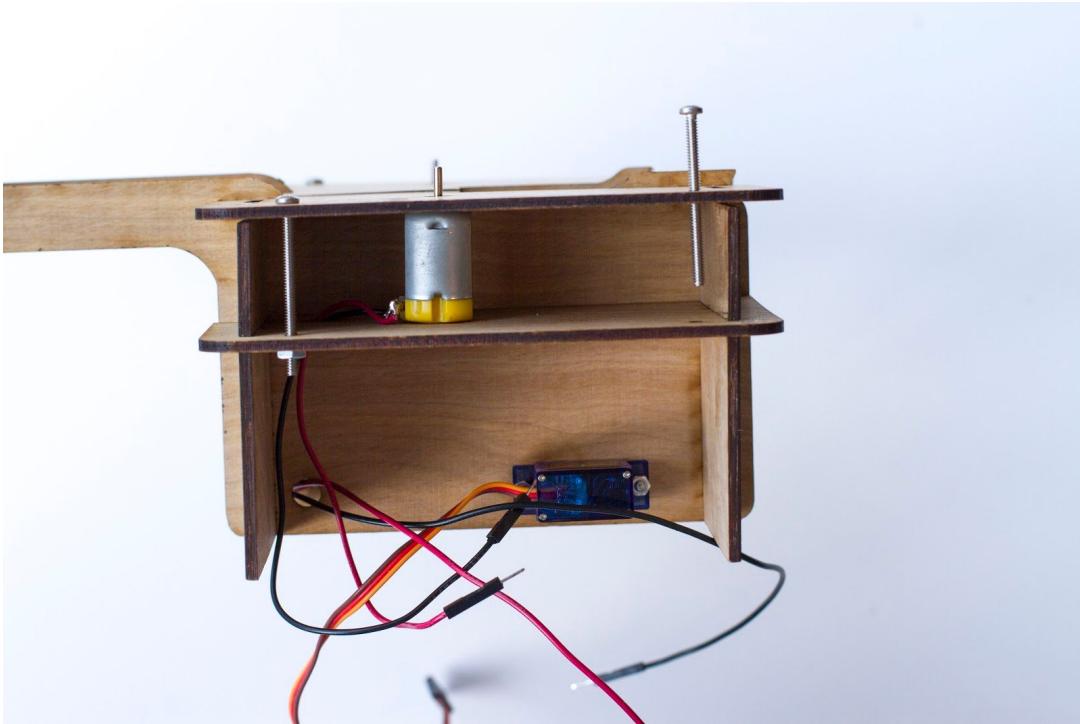
**Attach the other Guide Panel and repeat steps 5 - 7 for the other side.**



**8. Run the motor wires through the appropriate holes so that all wires are coming out of the same side.**



**9. Install each of the 4 long screws, adding a nut to the bottom of each.**



**10.**

**Remove the paper from each wheel.**



**11. Add wheels to each motor shaft.** These will fit very tight. Be sure to keep pressure on the bottom of the motor and NOT the wood or it will break. Press until the tip of the shaft is flush with top surface of the wheel.

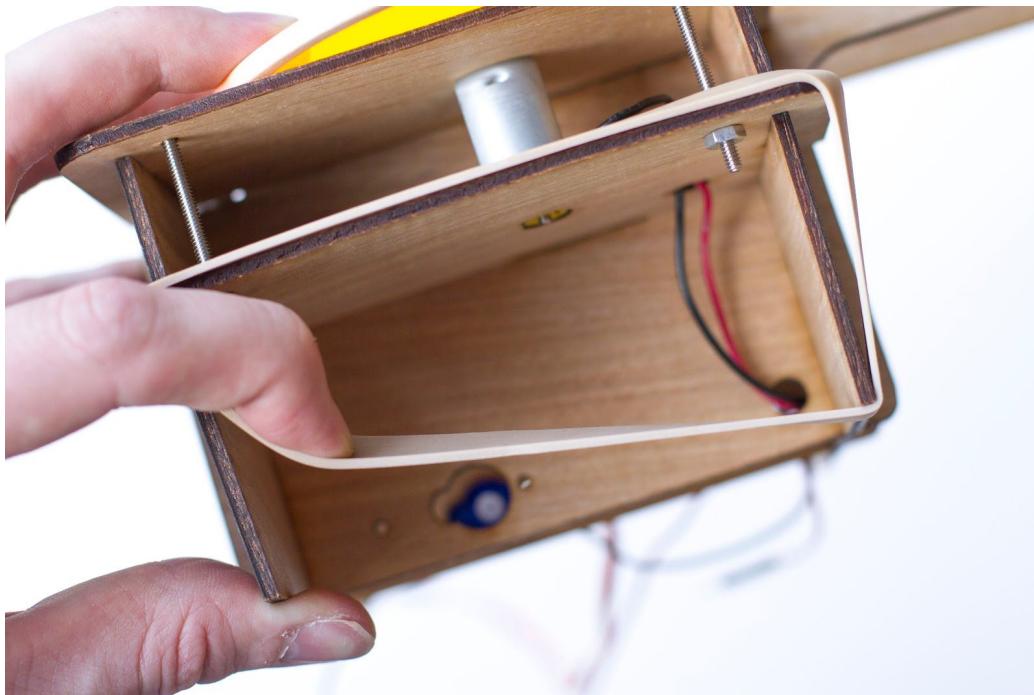


**12. Fasten a rubber band on the outside of the wheel.**

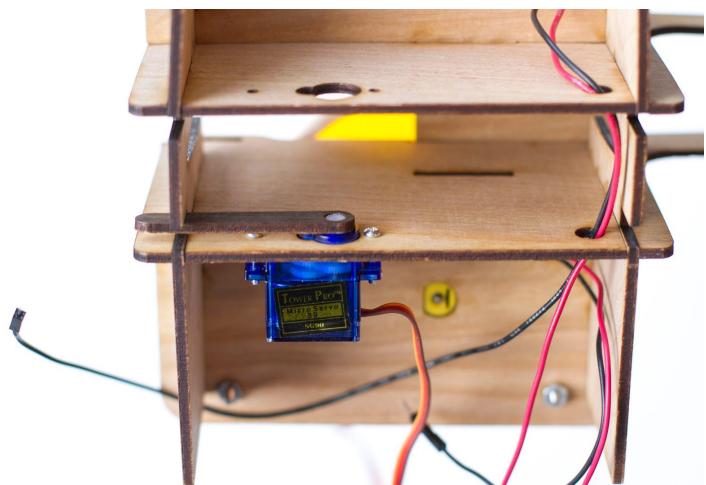
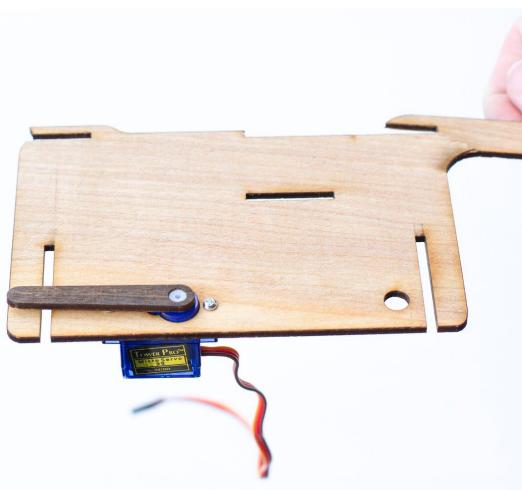


This is MUCH easier to do AFTER the wheels have been placed on the motors. Videos are available showing how we did it on [www.makexchange.com](http://www.makexchange.com).

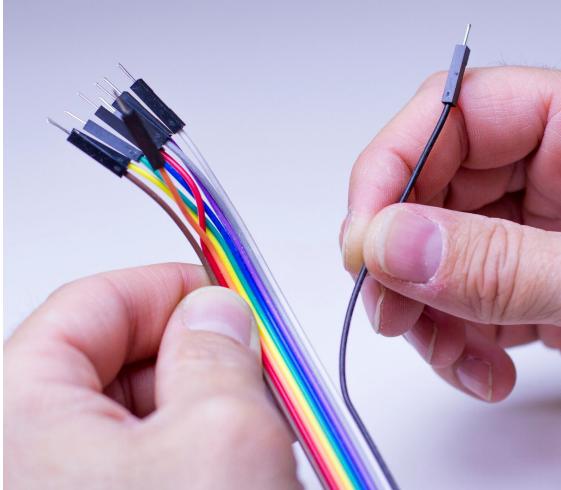
**13. (Optional) Add rubber bands to reduce shifting while in use.**



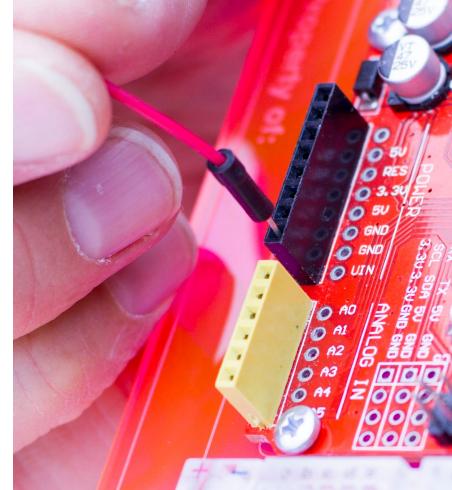
**14. Place Arm on Servo.** Place the acrylic servo arm on the white tip of the servo and rotate the arm forward until it is completely horizontal and facing the front. You may have to remove the arm and place it back on again.



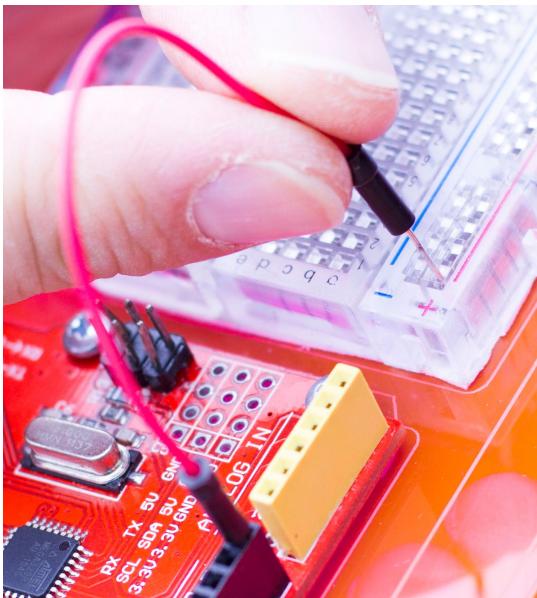
# BASIC WIRING SETUP



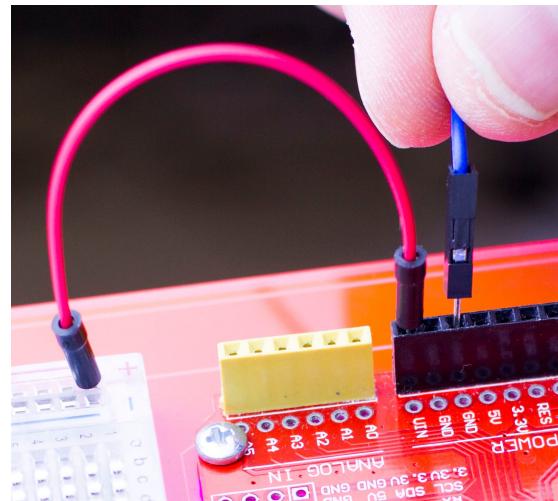
1. Select 2 short wires and remove them from the others. We will be using a **red wire** and a **blue wire**, but any 2 colors will work.



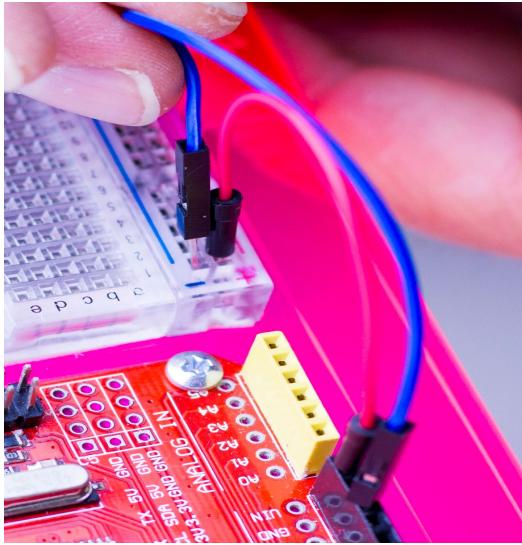
2. Insert one end of the **red wire** into the **VIN** pin hole on the Microcontroller



3. Insert the other end of the **red wire** into the **positive (+) column** on the breadboard



4. Insert the **blue wire** into the pin hole on the Microcontroller labeled **GND** for



- Insert the other end of the **blue wire** to the **negative (-) column** on the breadboard



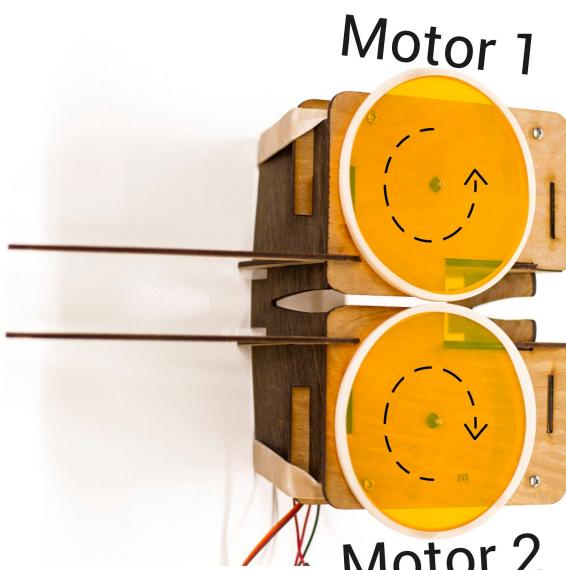
## WARNING:

### NEVER NEVER NEVER...

Never launch while someone is standing in front of the launcher.

### NEVER NEVER NEVER...

Never place ANYTHING but a paper airplane in the launcher.



### Motor Basics

When the red wire of the motor is connected to positive and the black wire of the motor is connected to negative (ground), the motor turns counter-clockwise.

Motor 1 in the picture to the left is turning counter-clockwise.

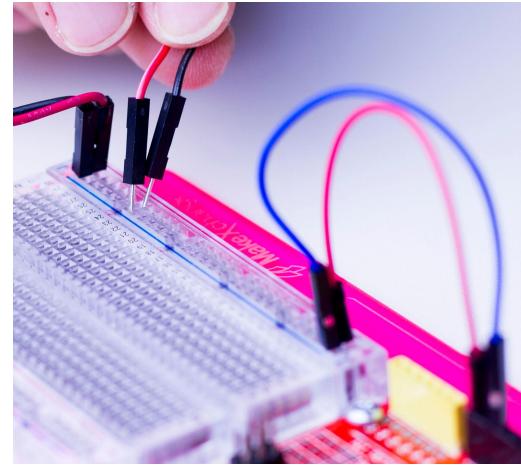
But what happens when we switch the wires? What happens if we connect Red to negative and Black to positive?

When that happens, it causes the motor to turn in the ***opposite direction!***

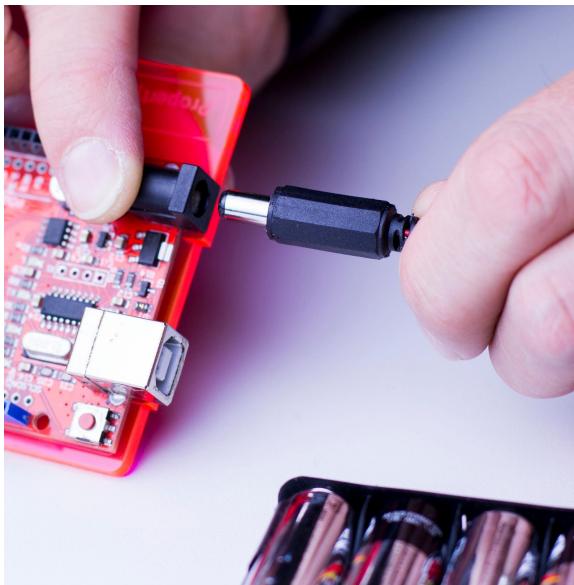
For the launcher to work, we need the motors to go in opposite directions. This will ensure both wheels grip the airplane and thrust it forward through the middle slot.



- From **Motor 1** connect the **red wire** to the **positive (+) column** on breadboard and the **black wire** to the **negative (-) column** on the breadboard.



- From **Motor 2** connect the **red wire** to the **negative (-) column** on breadboard and the **black wire** to the **positive (+) column** on the breadboard.



- Plug in the **battery pack** and make sure the motors are spinning as shown above. To change the direction of spin, simply switch the motor's **red** and **black** wires to the opposite column on the breadboard.

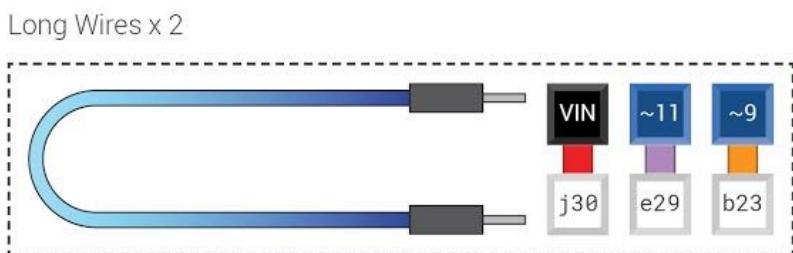
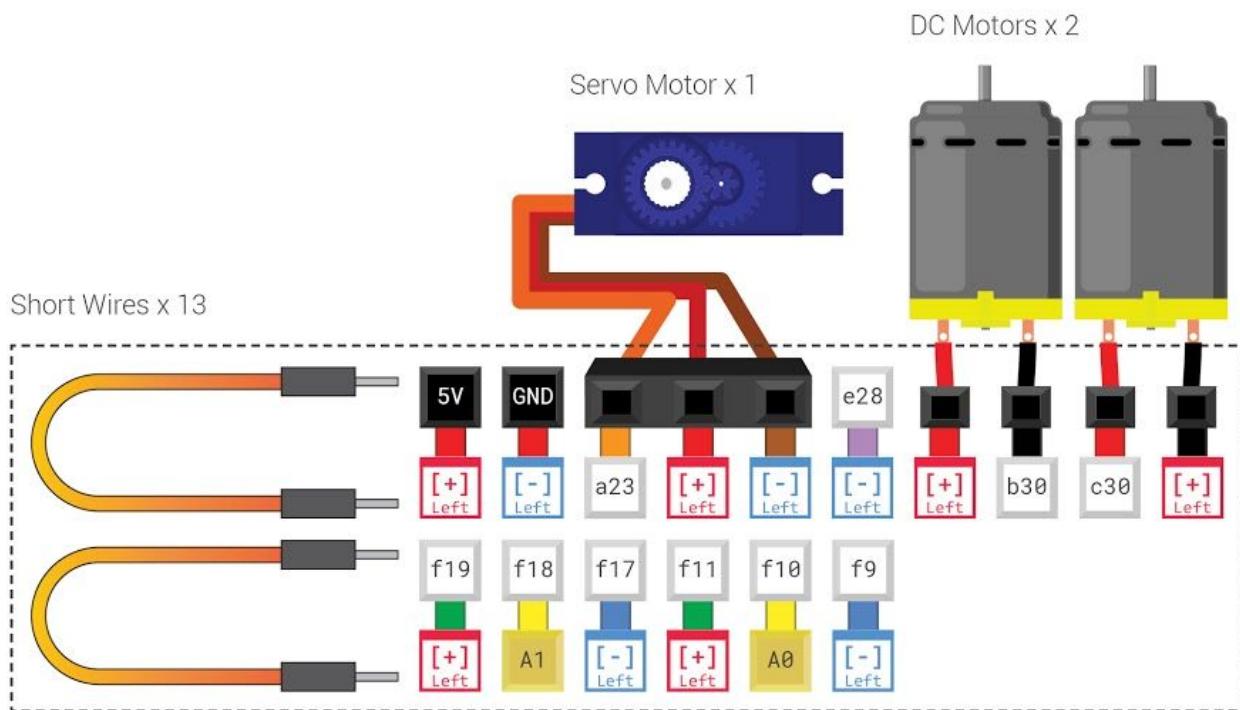
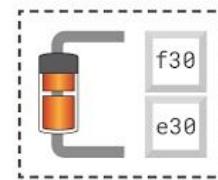
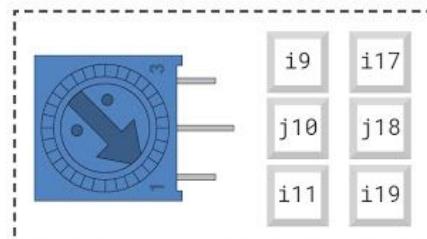
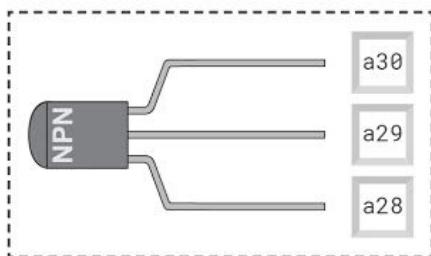
## Start Launching Airplanes!

You are now ready to start launcher airplanes. To turn off the launcher, you'll need to pull the power plug.

If you want to wire the launcher up so that you can control the speed of the launcher and the trajectory angle, read the next section.

**BE SAFE!! NEVER LAUNCH AT PEOPLE!  
WEAR APPROPRIATE EYE PROTECTION**

# ADVANCED AIRPLANE LAUNCHER WIRING



# FULL AIRPLANE LAUNCHER CODE

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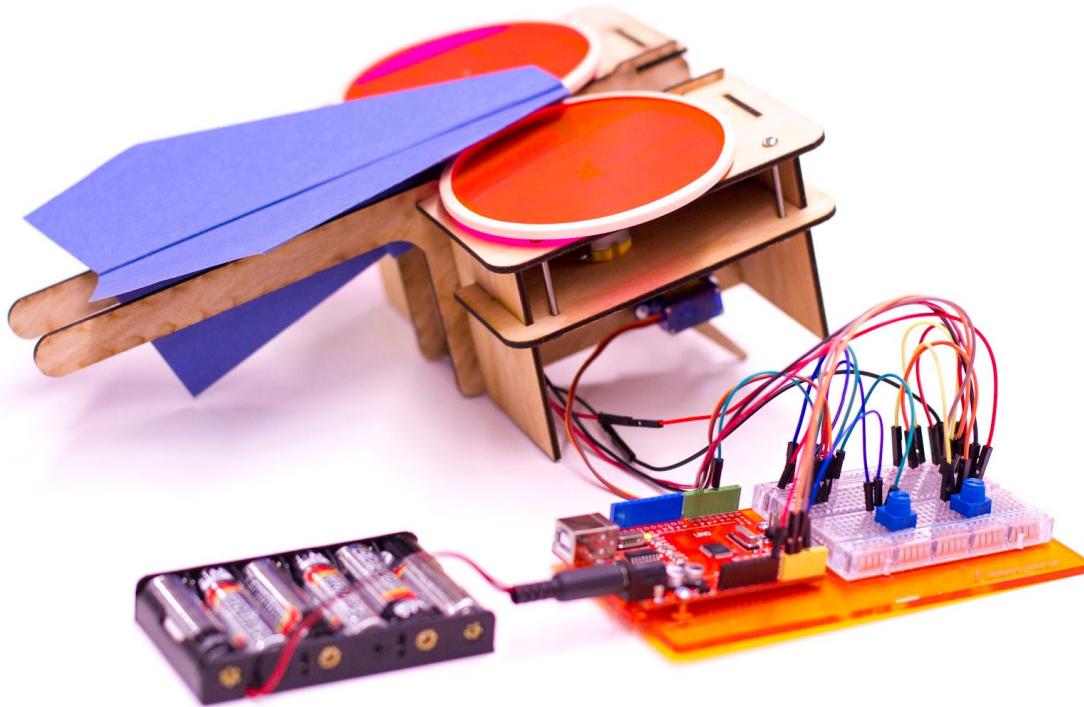
```
1 #include <Servo.h>
2
3 int motor_potpin = 0; // analog pin used to connect the motor potentiometer
4 int servo_potpin = 1; // analog pin used to connect the servo potentiometer
5 int motor_val; // variable to read the value from the analog pin
6 int servo_val; // variable to read the value from the analog pin
7 Servo myservo; // create servo object to control a servo
8 int motorPin = 11;
9
10 void setup()
11 {
12     myservo.attach(9); // attaches the servo on pin 9 to the servo object
13     pinMode(motorPin, OUTPUT);
14 }
15
16 void loop()
17 {
18     // Read the analog value of the potentiometer (value between 0 and 1023)
19     // and scale it down to use with the motor (value between 0 and 255)
20     motor_val = map(analogRead(motor_potpin), 0, 1023, 0, 255);
21     // Read the analog value of the potentiometer (value between 0 and 1023)
22     // and scale it down to use with the servo (value between 0 and 180)
23     servo_val = map(analogRead(servo_potpin), 0, 1023, 0, 90);
24     analogWrite(motorPin, motor_val);
25     myservo.write(servo_val);
26 }
```

Reach out to us with any questions or comments at:  
[support@makexchange.com](mailto:support@makexchange.com)

Visit [www.makexchange.com](http://www.makexchange.com) for advanced instructions on how to configure and program your launcher.

## LAUNCHING THE PAPER AIRPLANE

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To launch your paper airplane place it into the launcher as shown. For best performance, make sure the wings will go over the top of the wheels and gently tap the plane from behind.

**⚠️ CAUTION:** Only place paper airplanes in the launcher. Do not launch airplanes in the direction of other people.