Instructions for Constructing a Rodent Operant Bucket (ROBucket)

Required Parts

Part	Quantity	Source	Total Price
4 quart square container (6.5" x 6.5" x 8")	1	U.S. Plastic Corp	$5.97
Lid for 2- and 4-quart containers	1	U.S. Plastic Corp	$1.42
Arduino UNO - R3	1	SparkFun Electronics	$24.95
LCD keypad shield for Arduino	1	DFRobot	$14.55
Adafruit assembled data logging shield for Arduino	1	Adafruit Industries	$19.95
Kingston 4GB microSD high capacity (microSDHC) card	1	Office Depot	$8.99
Photo interrupter board with GP1A57HRJ00f	3	Karlsson Robotics	$14.97
Sainsmart 2-channel 5V relay module	1	O'Neill Computer Products	$18.99
12 VDC solenoid valve	1	American Science & Surplus	$3.25
Clear acrylic squares 1/2" acrylic square	1	U.S. Plastic Corp	$0.24
JST SH jumper 3 wire assembly - 8"	3	SparkFun Electronics	$4.05
Faceplate, 3 port	1	Zoro Tools	$7.91
Machine screw,flat,4-40x1/2 L, nylon	8	Zoro Tools	$0.32
Hex nut, machine screw, 4-40, black, nylon	12	Zoro Tools	$0.32
Wall adapter power supply - 9VDC 650mA	1	SparkFun Electronics	$5.95
DC barrel jack adapter - female	1	SparkFun Electronics	$2.95
1/2" straight cannula blunt end tip (15 gauge)	1	Fisnar	$0.24
Male luer with lock ring x 1/8" hose barb, nylon	1	Cole-Parmer	$0.34
Male luer with lock ring x female luer coupler, PC	1	Cole-Parmer	$0.56
BD 20mL syringe with Luer-Lok tip	1	Allegro Medical	$0.51
Masterflex platinum-cured silicone tubing, L/S 16, 25 ft.	0.5 Ft	Cole-Parmer	$1.18
Stor-All broom clip	2	Aubuchon Hardware	$3.38
Jumper wires premium 6" F/F	9	SparkFun Electronics	$2.99
Wing nut,6-32	2	Grainger	$1.07
Machine screw, flat, SS, 6-32x1.5 L	2	Grainger	$0.29
2-way 2.1mm DC barrel jack splitter squid	1	Adafruit Industries	$2.95
0.1" (2.54mm) crimp connector housing: 1x1-pin	9	Karlsson Robotics	$0.21
Female crimp pins for 0.1" housings	9	Karlsson Robotics	$0.54
3D printed housing	*1*	*Makerbot Replicator 2 Desktop 3D Printer*	*Variable*
Total			**$149.19**

Step 1: Drilling holes in the bucket

1. Print out the Adobe Illustrator files for the front and side panel on plain paper or removable labels (8½" x 11").

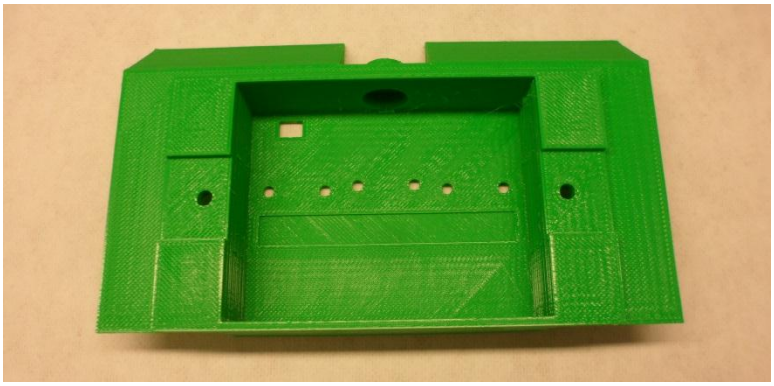
2. Place the templates on the bucket, with the side panel to the right of the front panel.

3. Drill seven $^{1}/_{8}$" holes and two $^{5}/_{16}$" holes where shown on the templates.

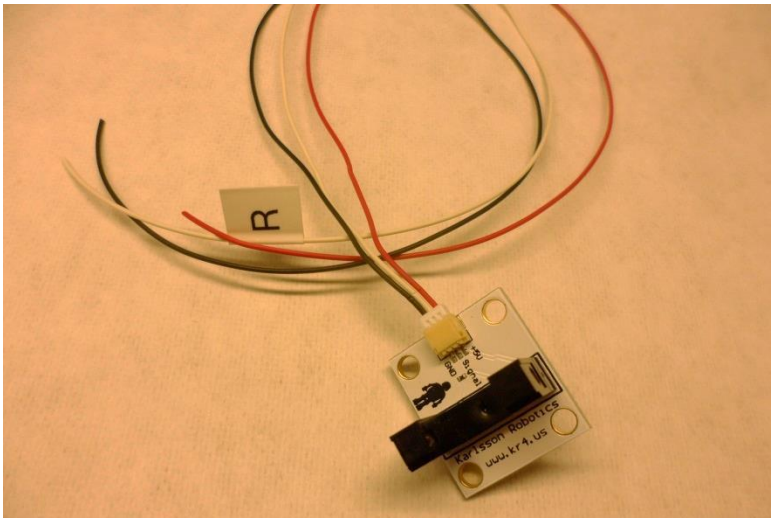
Step 2: Assembling the nose poke and drinking well enclosure

In this step, we will assemble the nose poke and drinking well enclosure and attach it to the inside of the bucket.

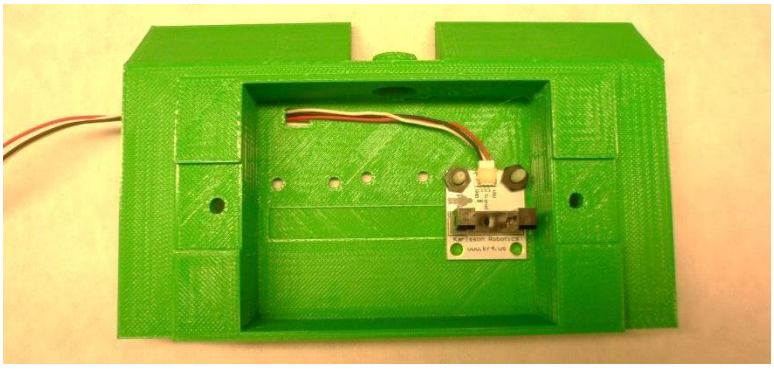
1. Print out the 3D housing. We used Makerbot PLA material and printed at a high resolution.

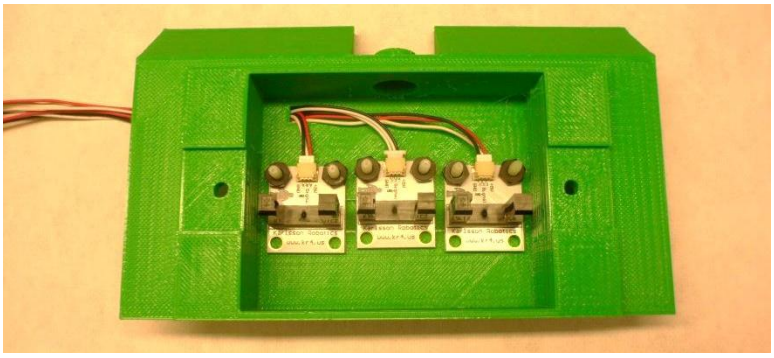


2. Plug three JST SH jumper 3-wire assemblies into three photo interrupter boards. Label the signal wire for each “L” (for left), “C” (for center), and “R” (for right).

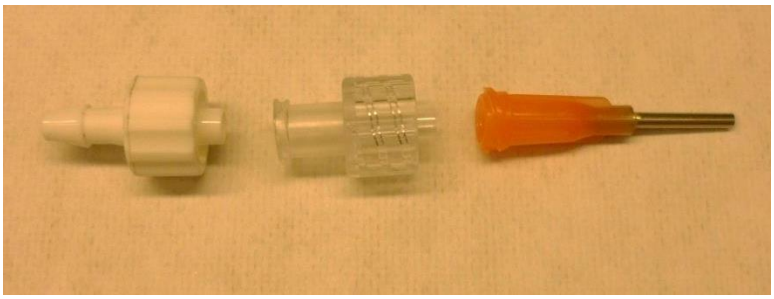


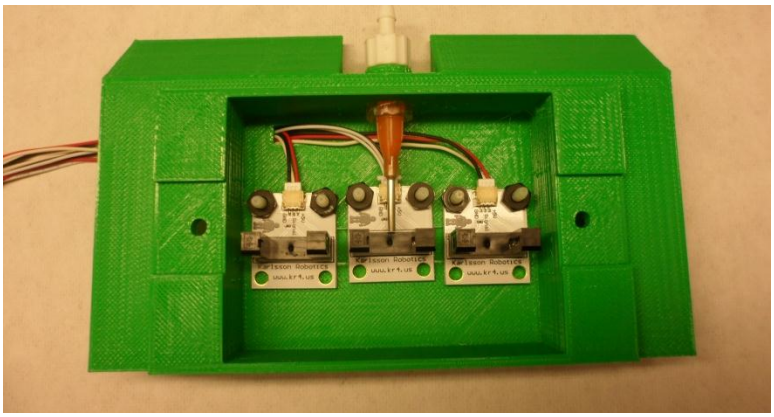
3. Use the nylon screws and hex nuts to secure the photo interrupter boards to the inside of the 3D printed cover and bring the wires to the outside of the cover using the hole in the top left of the housing.



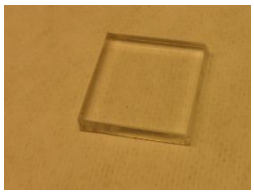


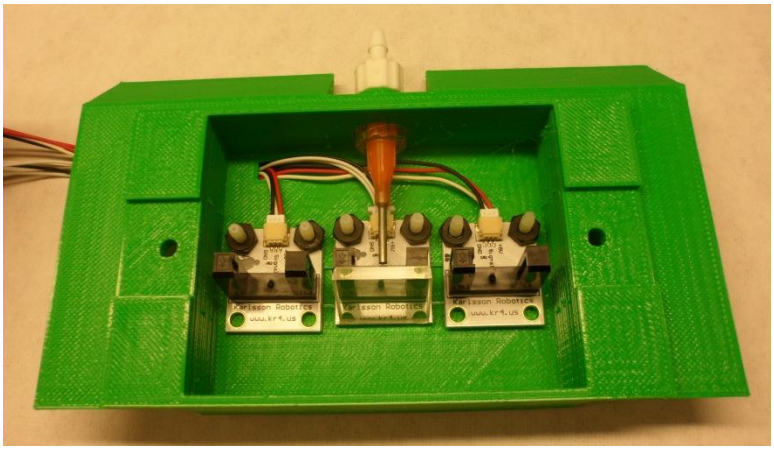
4. Assemble the blunt needle with the two luer lock pieces, and screw together securely in the top hole in the housing.



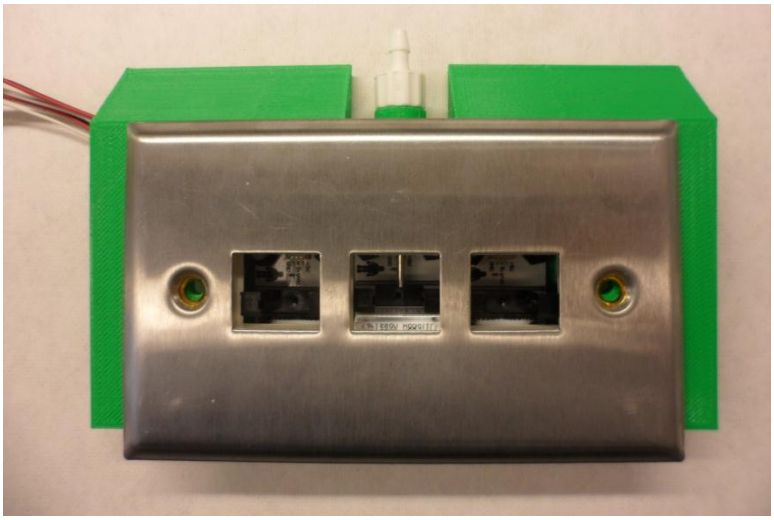


5. Place the ½” piece of plastic under the center poke.





6. Place the faceplate over the housing, such that the plastic piece is clamped in place, and everything is secure.



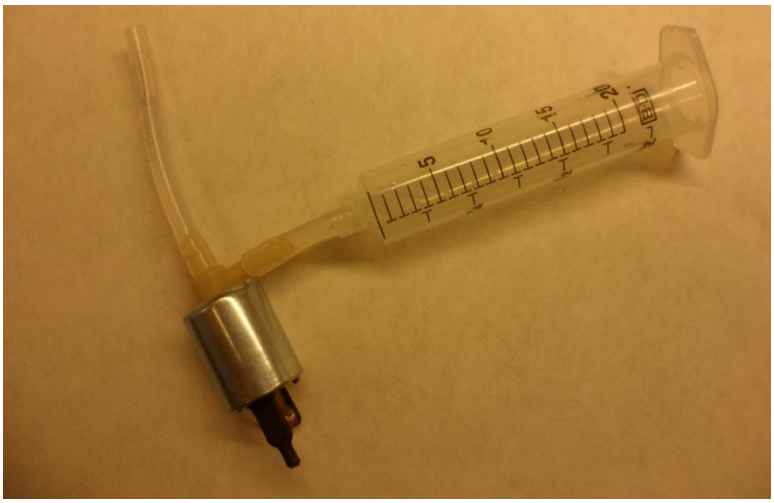
7. Use two 1.5” 6-32 screws and wing nuts to secure the entire apparatus to the inside of the bucket.

Step 3. Mounting the solenoid valve

In this step, we will mount the solenoid valve and liquid syringe on the outside side of the bucket.

1. Using nylon screws and hex nuts, attach the two broom clips to the two 5/16” holes on the side of the bucket.

2. Attach the syringe to the solenoid valve with a piece of tubing that is approximately 1.5”. Leave a piece of tubing (approximately 3”) hanging off the output of the solenoid.



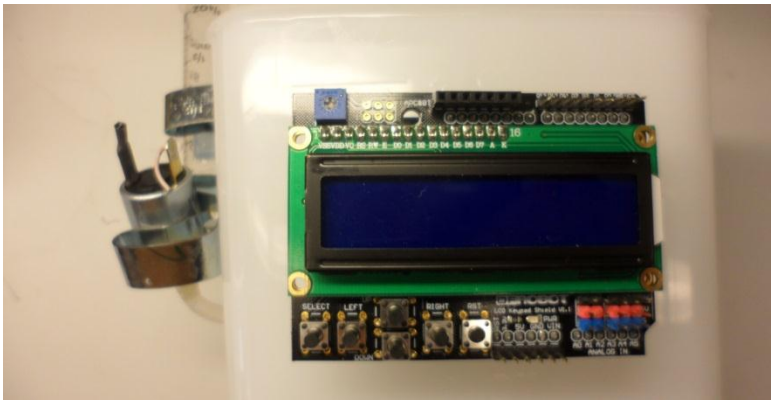
3. Mount the syringe and solenoid in the broom clips, and attach the tubing to the hose barb on top of the nose poke apparatus.

Step 4. Assembling the side panel electronics

In this step, we will assemble the side panel electronics and attach them to the outside front of the bucket.

1. Place the Arduino Uno so that the top right and bottom left mounting holes align with the top two holes in the side panel. Secure the Arduino board in place using the nylon screws and hex nuts. Place an additional hex nut between the bucket and the board at each mounting point, to allow for a small space between the Arduino and the bucket.

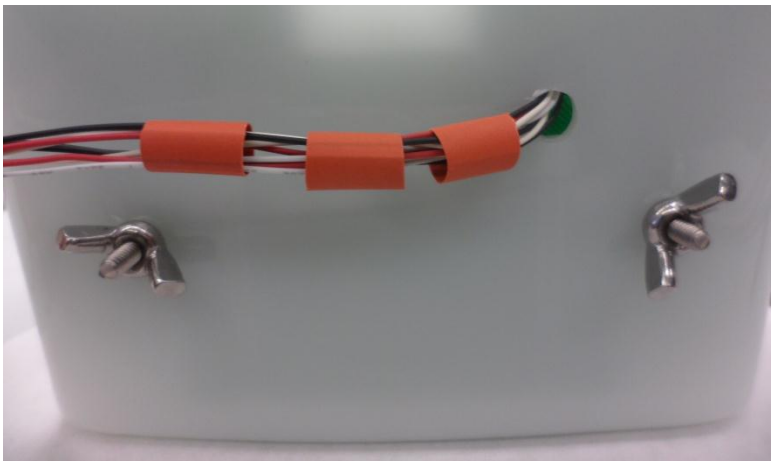
2. Fit the SD shield (with stacking headers soldered on) on top of the Arduino and the LCD shield on top of the SD shield.



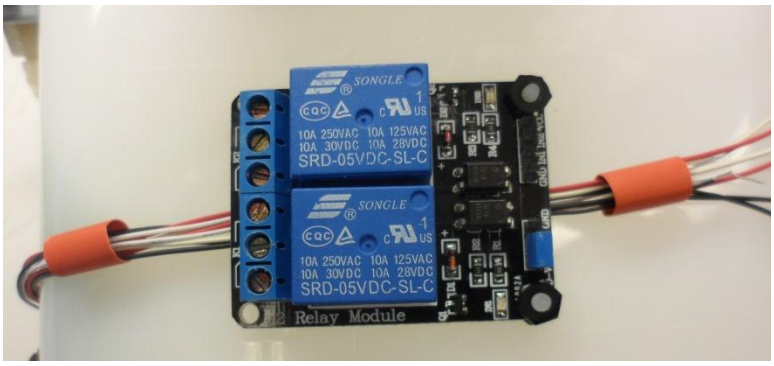
3. Secure the relay module to the bottom two holes in similar fashion. Orient the relay so that the male pins are on the right side.

Step 5. Wiring up the front electronics
In this step, we will wire up the front electronics.

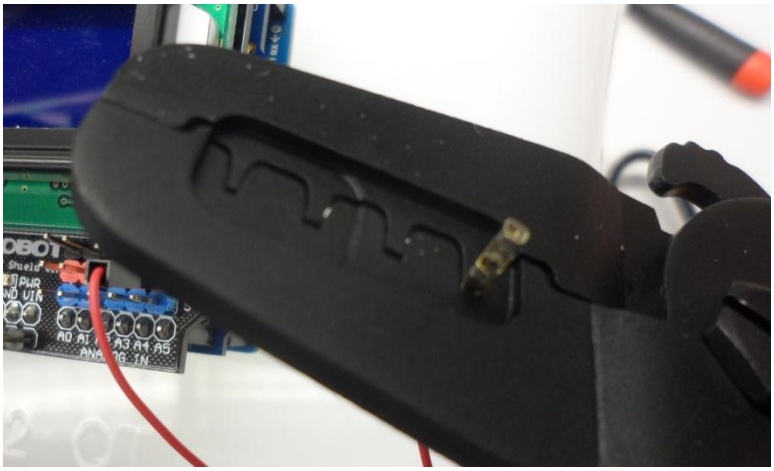
1. Place three short pieces of heat shrink tubing around the bundle of 9 wires coming from the nose poke apparatus. Do not heat shrink these yet.



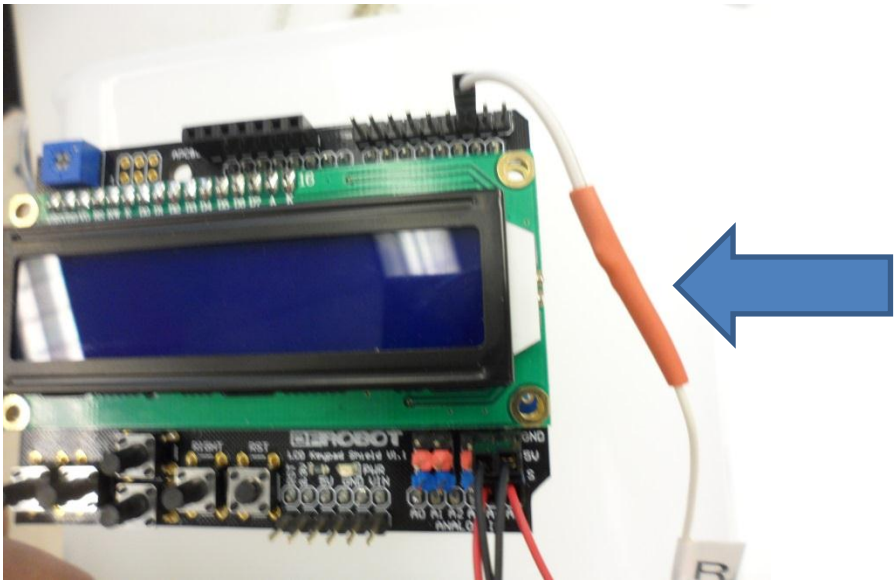
2. Route this bundle of wires underneath the relay module (you may want to unscrew it to do this).



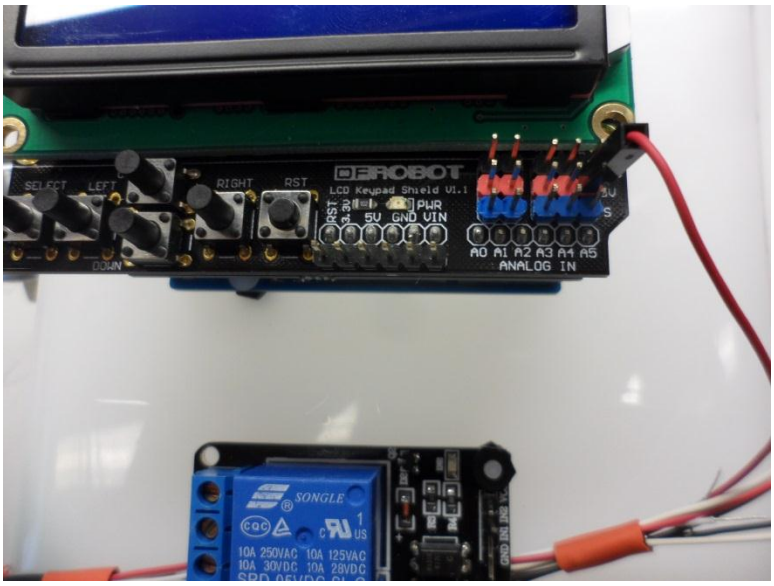
3. If these wires are long enough to reach the LCD keypad shield, place a crimp connector on the end of each.



4. If any wires are not long enough, solder a header wire with a crimp connector on it to increase the length so it can reach.



5. Plug the power and ground wires from the three nose pokes (6 wires total) into the power distributor on the LCD shield, such that each one has its own power and ground.

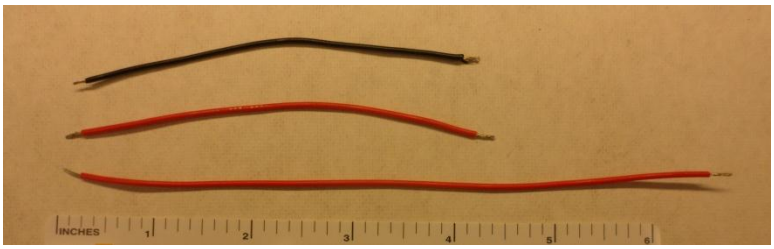


6. Plug the remaining 3 wires from the nose poke enclosure into the input/output pins at the top of the LCD shield, in the following order:
   Pin 0: Active poke (left)
   Pin 1: Drinking well (center)
   Pin 2: Inactive poke (right)

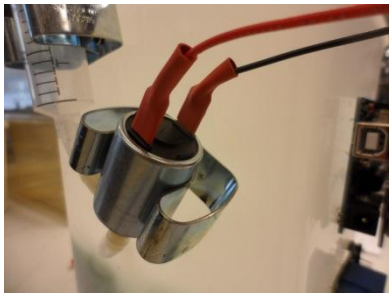
7. Use three F/F jumper wires to connect the relay module to the GND and 5V pins on the LCD shield, and attach IN1 on the relay module to Pin 3 on the LCD shield.

Step 6. Wiring up the solenoid (almost done!)

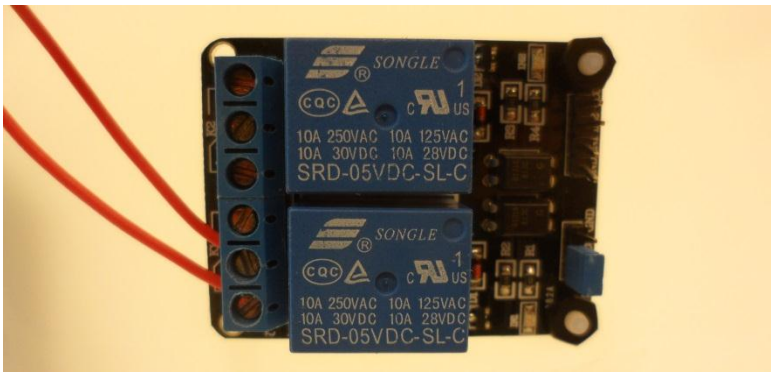
1. Cut and strip one red wire approximately 7” long, and one red and one black wire, each approximately 4.5” long.



2. Solder the long red wire, and one of the black wires onto the solenoid, and heat shrink terminals.



3. Screw the long red wire into the bottom port of the relay module, and the short red wire into the port that’s 2nd from the bottom.



4. Screw the black wire from the solenoid, and the short red wire into the DC barrel jack.

5. Plug the barrel jack Y adapter into the DC barrel jack and the Arduino power input, and attach to a 9V DC, 650 mA power supply.

6. **You're done!**

Step 7: Uploading the ROBucket program and testing the hardware

1. Download the ROBucket sketch from the website. Robucket_1poke.ino is for ROBuckets that only have an active poke and a drinking well, whereas Robucket_2pokes.ino is for ROBuckets that have both an active and inactive poke.

2. Upload the sketch to the Arduino Uno with a USB (Type B) cable.

3. Insert an SD or microSD card into the data logging shield before turning the ROBucket on. ROBucket will display an error message ("Card Failed") unless there is a functional SD card in the data logging shield.

4. Fill the syringe with water.

5. Power up the ROBucket. The first time you fill the syringe with water, you might need to hit the Reset button on the LCD shield a few times to run the water through the tubing.

6. Push the Up button to start the FR1 program.

7. Check that all three pokes register on the LCD screen, that the active poke dispenses water into the drinking well, and that the data is being properly logged onto the SD card.

ROBucket Wiring Diagram