Gravity Battery

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Project Description

Renewable energy is the number one way for mankind to reduce its carbon footprint. But oftentimes, when renewable energy is working, it's working so efficiently that it's generating more power than is being consumed, allowing it to be dispersed without usage onto the grid. The most common solution currently being designed to fix that is a battery. But the problem with modern batteries is that they're expensive, hard to produce, and often rely on ingredients that are difficult to source, and sometimes even involve child labor. Nickel, cobalt, and lithium are elements that come from the Democratic Republic of Congo, Chile, Russia, China, and the Philippines, each of which has had violations of human rights and child labor laws in their production. And if child labor and human rights violations weren't bad enough, the batteries themselves are expensive and degrade over time.

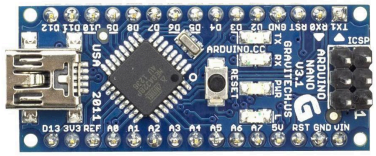
That's where the concept of a **Gravity Battery** comes in. Originally, the earliest forms of gravity-powered devices, like pendulum clocks, were developed in the 17th century by Christiaan Huygens. Now, there are two common types: Wet and Dry.

- **Wet battery** works by pumping water to a high point. Then, at a later time, a valve is opened, and the water flows down through a generator or water wheel. This process converts kinetic energy to potential energy, and then back into kinetic energy when needed. While it's not 100% efficient, it stores significantly more power than simply letting it dissipate over the grid.
- **Dry gravity battery** uses excess power to lift a block or heavy object up a tower or into a rest position. Then, when the power is needed again, the object is slowly dropped, turning a generator as it descends.

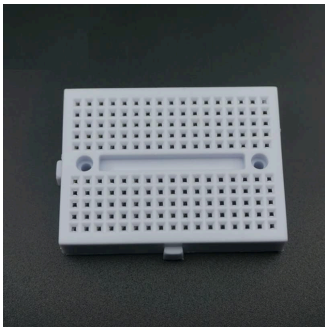
While gravity batteries are an awesome emerging technology, you can't exactly buy one for a personal solar, wind, or geothermal system (and honestly, it's less fun to just buy it). So, this chapter of our book will show you how to build a personal gravity battery that also functions as a water storage system. This setup allows for true, 100% round-the-clock power that works regardless of energy production, since excess power is always stored. Aside from replacing a few small parts over time, the system should last around 20 years.

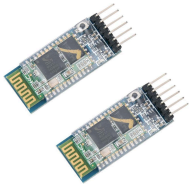
Bill of Materials

Part	**Link**	**Quantity**
Water Wheel/ Alternator	See page below	1

55-gallon barrels (For a Family of four, get 8). Facebook Marketplace, Docs, and Warehouses are usually full of them for free or cheap. Wash them out. 		2/Per Person (For a Family of four, get 8). Facebook Marketplace, Docs, and Warehouses are usually full of them for free or cheap.) Wash them out.
Arduino Nanos (In case you break one or it doesn't work) 	https://www.amazon.com/dp/B07G99NNXL?ref_=ppx_hzsearch_conn_dt_b_fed_asin_title_1	4
Arduino-powered solenoid valves 	https://www.amazon.com/dp/B0CKYRR8Y1/ref=twister_B0CKYVX8WJ?_encoding=UTF8&th=1	2
½ HSP Relays	https://www.amazon.com/dp/B0CHFJSNP6/ref=twister_B0CHFDC6RF?_encoding=UTF8&th=1	2

		
Solar Panels 	https://www.amazon.com/dp/B09JFYPDNC?ref_=ppx_hzsearch_conn_dt_b_fed_asin_title_1&th=1	2
Battery Packs 	https://www.amazon.com/dp/B094Y1R46V?ref_=ppx_hzsearch_conn_dt_b_fed_asin_title_1&th=1	2

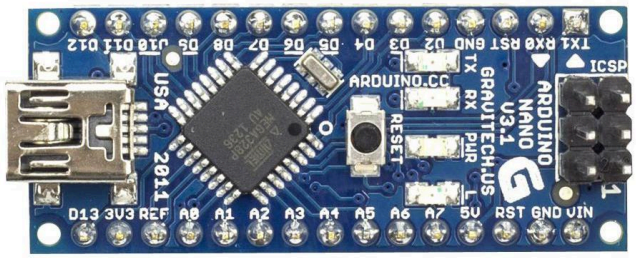
Pack Of Wires 	https://www.amazon.com/dp/B01EV70C78?ref_=ppx_hzsearch_conn_dt_b_fed_asin_title_3	1
Pack of Bread Boards 	https://www.amazon.com/dp/B09YXQJMTG?ref_=ppx_hzsearch_conn_dt_b_fed_asin_title_1	1
Measuring Tape		1
PLA Filament 	https://bit.ly/3Gu28xX	1
3D Printer	https://bit.ly/3Sc3rUJ	
Pallet 48in by 40 in	(Facebook Marketplace)	2
100ft of Reinforced Water Pipe	https://www.homedepot.com/p/Advanced-Drainage-Systems-1-in-x-100-ft-IPS-100-PSI-UTY-Poly-Pipe-1100100/202282463	1

Pipe Fittings 3/4 in.- 1-3/4 in 	https://www.homedepot.com/p/Everbilt-3-4-in-1-3-4-in-Stainless-Steel-Hose-Clamp-10-Pack-672055E/202262871	1 Pack
Plumbers Tape 	https://www.homedepot.com/p/Harvey-1-2-in-x-260-in-Thread-Sealing-PTFE-Plumber-s-Tape-178503/202280370	1 Roll
Elevated Surface of 25 + ft or buy the lumber to build a tower with bolts for structural support		
Pump 	https://www.amazon.com/Submersible-Screw-Water-Stainless-5-5GPM/dp/B0C33NJGRV/ref=cm_cr_arp_d_product_top?ie=UTF8	1 Pump
Big Solar Panel	https://bit.ly/4jtwZcv	Get 1-3 (This isn't the one I used but a good option)
Battery	https://www.amazon.com/Mighty-Max-Battery-Storage-Batteries/dp/B01JNZ1GGE	1
Electrical Box	https://bit.ly/42MceSd	2
Bluetooth Module 	https://bit.ly/4lTjG6R	1 Order of 2
Diode	https://bit.ly/42RnbSF	10

TIP 120	https://bit.ly/3YRLr5O	5
OnShape	https://cad.onshape.com/documents/fc32e2dd5568f45e175a29fa/w/2282226ec02c83319e4ff951/e/8a479de4819fdca40fda4a72	Print all parts
Code	https://github.com/Hacking-The-Apocalypse/2025-Spring-GravityBatteryGroup	Use Link

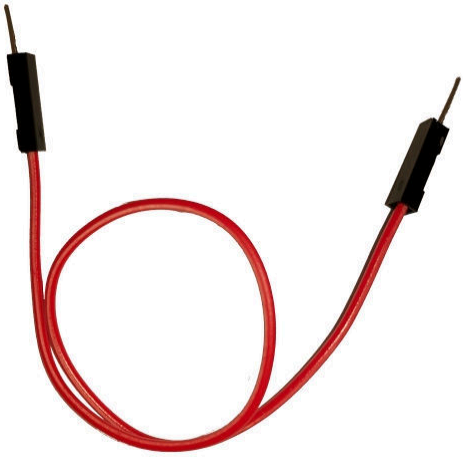
Assembly Instructions, step-by-step, w/ Images

- Step one: Unpack all Items and sort
- Step two: Grab the two Arduino Nanos

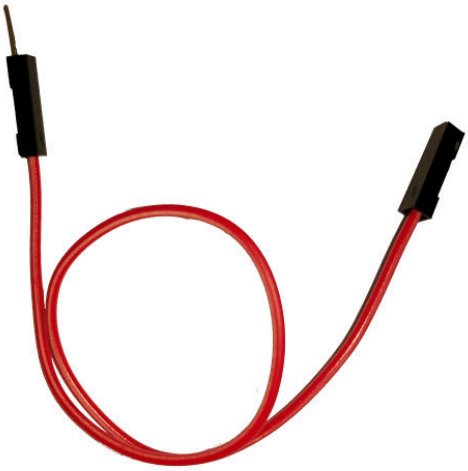


- Step Three: Grab one of the blue wires that comes with the Arduino Nano

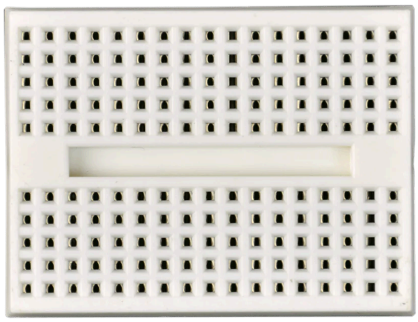
- Step Four: Grab 5 Male-Male Wires, pointy pieces on both sides



- Step Five: Grab 4 Male-Female Wires, Pointy Piece on one side, non-pointy piece on the other

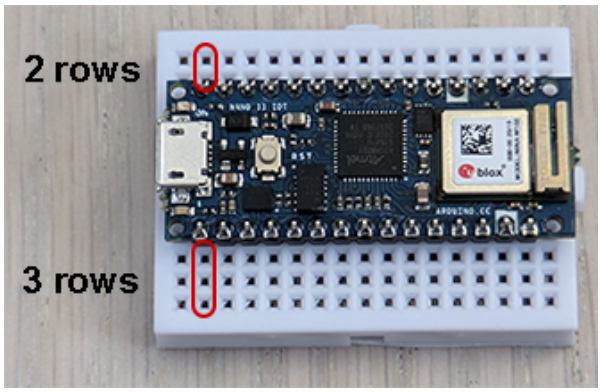


- Step 6: Grab Two Breadboards

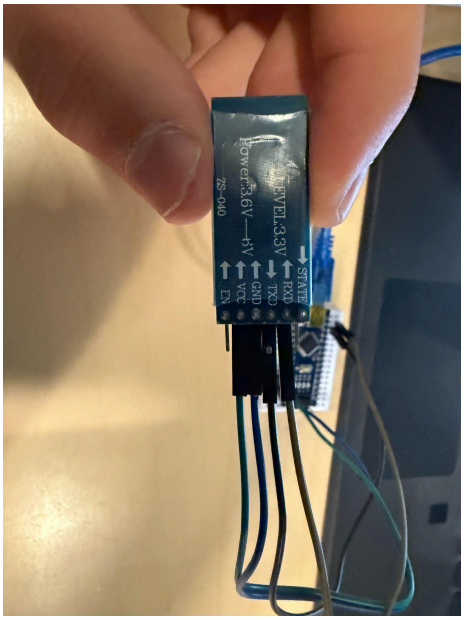


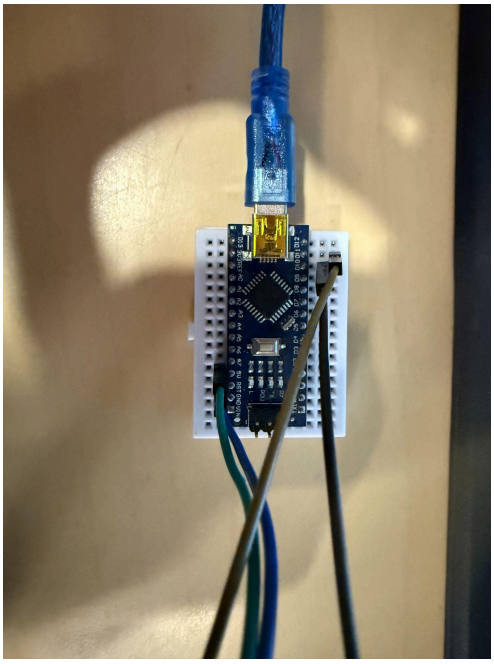
- Step 7: Grab a ½ HSP Relay

- Step 8: Place Nano on the end of the breadboard so the port is at the end of the board, place three rows on top for the D12, D11 side, and two on the bottom for D13, 3V3, REF, AC side



- Step 9: Get Four Male to Female Wires(Use Bluetooth Video Above for setup)
  Plug One: from D11 (On Nano), so pick a hole in front of D11 to place the Male or pointy head into Wire On(On BreadBoard) -> RXD on the Bluetooth Relay should be female side non pointy.
  Plug Two: From D10 (On Nano Breadboard) to TXD (On Bluetooth Relay)
  Plug Three Find 5V On Nano -> VCC (On Relay)
  Plug Four: Find GND (On Nano) -> GND (On Relay)

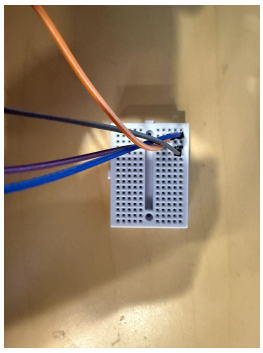
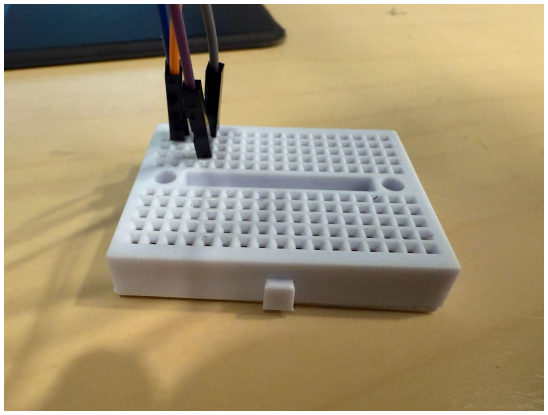
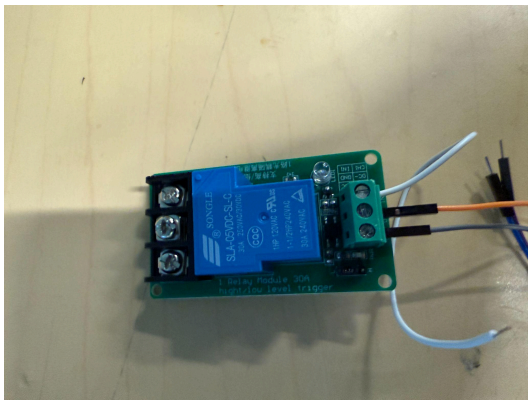




- Step 10: Grab One More Empty Breadboard and a 1/2HSP Relay
  Step 1 Unscrew a slight bit but keep screw in DC+ DC- and IN on the relay
  Step 2: Place three different male wires into DC+ DC- and In once placed inside re screw them screws so that you can't pull the wires out
  Step 3: Plug DC+ and DC- into the bread board put them in different rows
  Step 4: Grab two more male-to-male wires and plug one into the same row as DC+ from above, and one into DC-
  Step 5: The wire that is connected to the DC+ plug goes into the same row as the 5V on the Arduino Nano

Step 6: Plug the wire connected to the same row as DC- into the GND row on the Arduino

Step 7: Return to the relay, the last wire not plugged in, connect to the row associated with D4. On the Arduino Blue USB cable into the port on the Arduino Nano

- 
- 
- 
- Step 11: Grab Battery Pack

  Connect the blue USB head to the battery pack and the other end of the

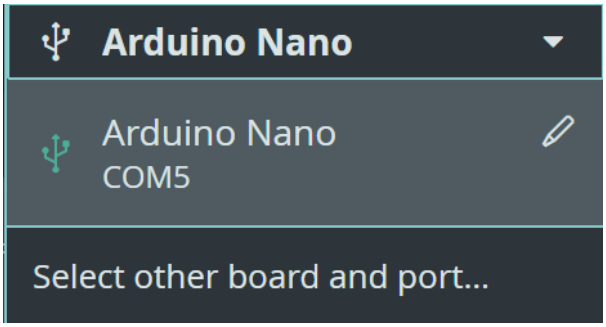
  If wired correctly, you should see a red light next to the power on the nano, a red light on the relay, and a red light blinking on the Bluetooth module

  This is going to be the Master

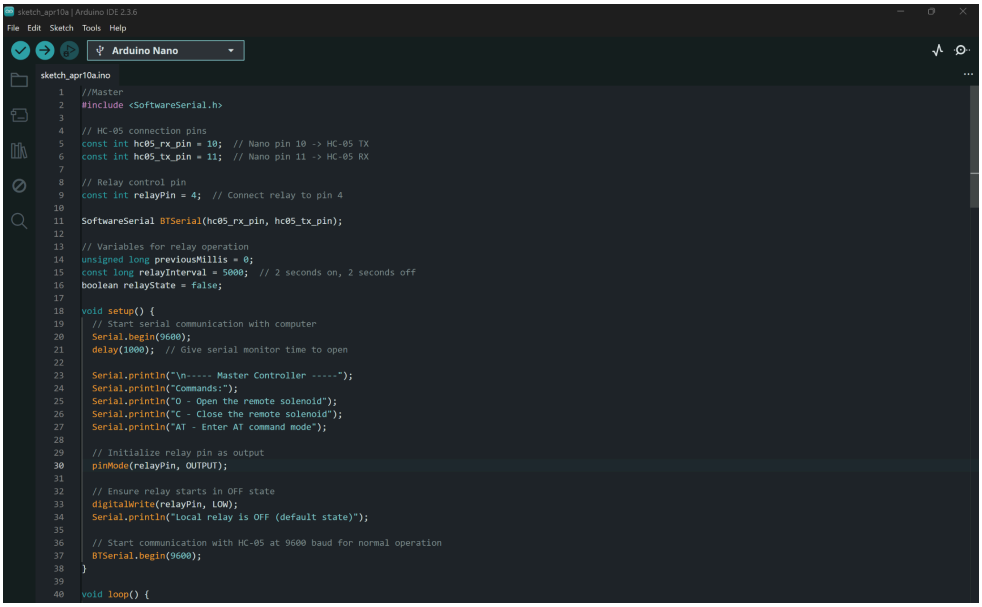
  Download the Arduino IDE

Once you see this

Unplug your USB cable from the battery pack and connect it to your computer.
You should see something similar to this.



If you don't see it, click Select Other Board and Port and scroll until you see Arduino Nano
Click Arduino Nano, and Under Ports, Select Arduino Nano. If you don't see anything, the board isn't properly connected to your computer.
Repeat the steps above
Once Arduino Nano is bolded and not thin as above
Copy and paste the Master code
Then you should see this



Click the check, and if you see no errors, click -> then you will see a box in the bottom right corner that says uploading. if successful your relay should be making a clicking sound every few seconds.
Once you hear the click, return to your Bluetooth module, unplug the connection to your computer until there is no power on the Arduino.

Then, in the Arduino IDE, Click this

Make sure it's set like this.

You may need to connect the device to see the 9600 Baud
If you had to reconnect your device to see that it unplugged once more
Replace the Master Code with the Bluetooth Code
Then hold down the button on the Bluetooth module again and plug the device in
The Bluetooth module should be blinking once every 2-3 Seconds
Once it's blinking, you should see
----- HC-05 AT Command Interface -----

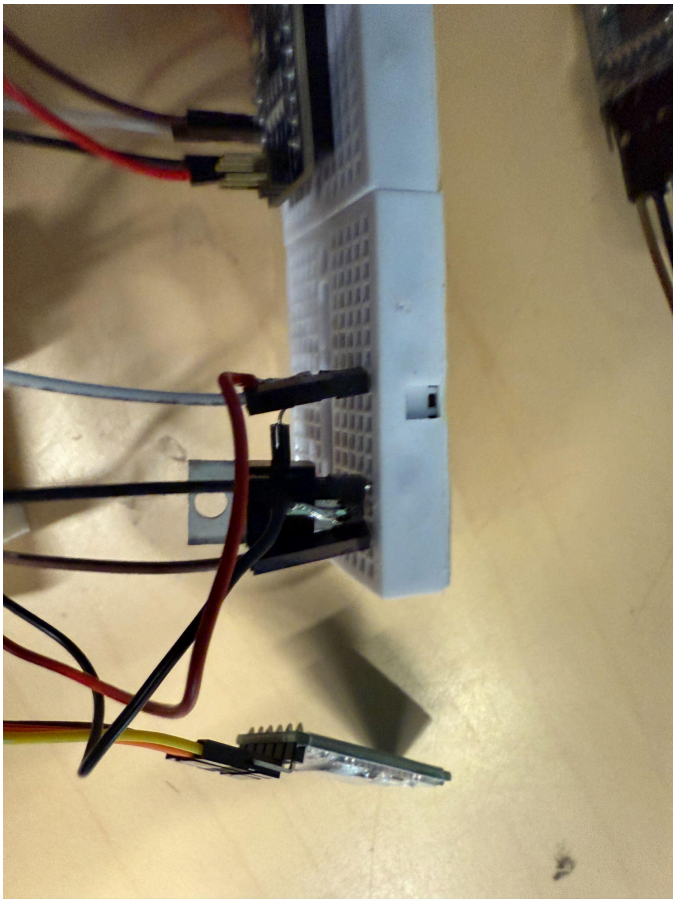
Make sure HC-05 is in AT mode (LED blinking slowly)

Enter AT commands in the Serial Monitor

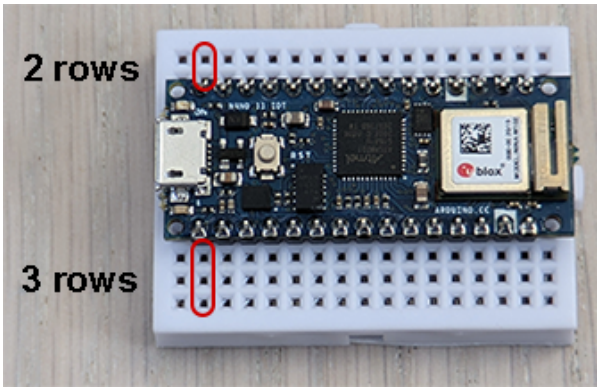
For example: AT, AT+VERSION, AT+NAME, etc.
Type AT+ROLE=1
Then Type AT+ROLE?
You should get
Response:
+ROLE:1
OK
If you see this, then you're great.

- Step 12: We have set up the master now, we need to set up the slave(Poorly Named, I know, but that's how it is). Grab another Nano, 2 Breadboards, a Bluetooth Module, and a Blue Cable. Grab your solenoid, grab one TIP 120, and one Diode
- Step 13: Setting Up Slave

Step One: Connect two breadboards using hooks.



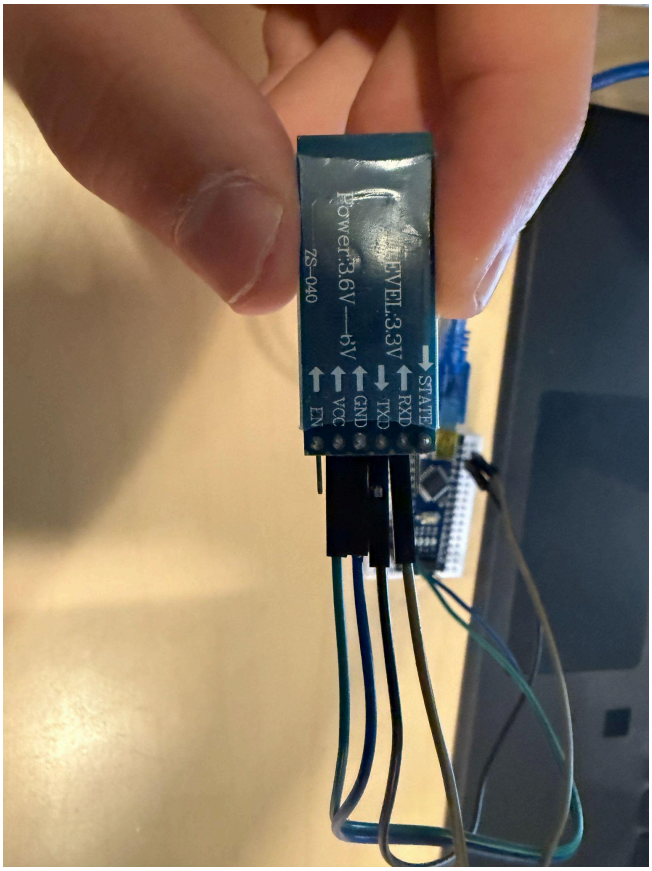
Step Two: Place Arduino on breadboard like this



Step three: Grab Four Male to Females

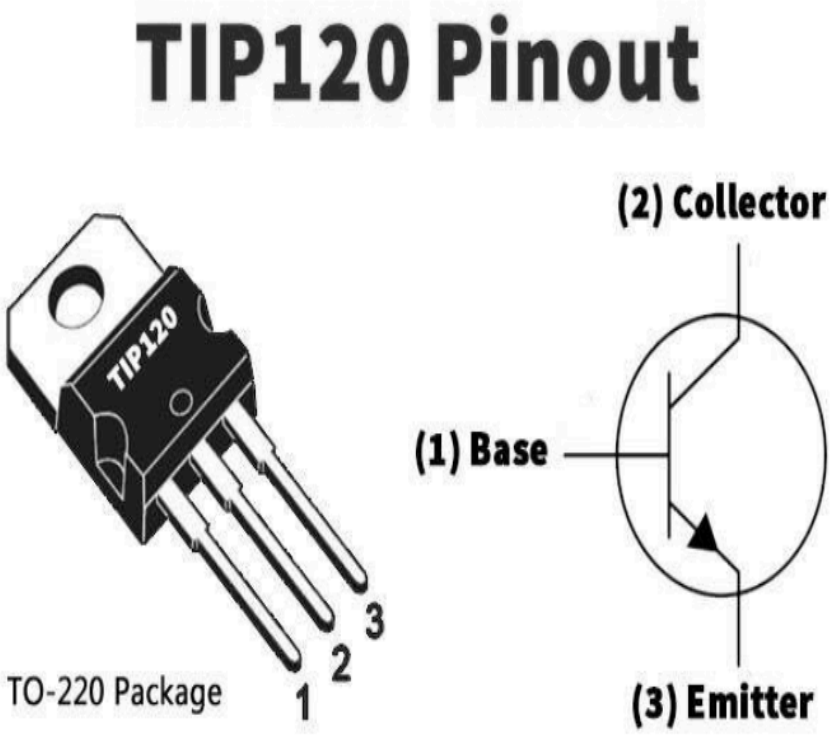
- Plug One: from D11 (On Nano), so pick a hole in front of D11 to place the Male or pointy head into Wire On(On BreadBoard) -> RXD on the Bluetooth Relay should be female side non pointy.
- Plug Two: From D10 (On Nano Breadboard) to TXD (On Bluetooth Relay)
- Plug Three Find 5V On Nano -> VCC (On Relay)

- Plug Four: Find GND (On Nano) -> GND (On Relay)



Now on the second board

- Grab two male-to-male wires
- Connect One to the 5V Row on the Arduino and then to its own row on the new breadboard.
- Connect the other to the GND Row of the Arduino Nano and its own Row of the Bread Board.
- For the wire you connected to 5V on the Nano, use that row and connect the red wire of the solenoid to the same row.
- Grab the Diode and find the part that has the silver line. use the metal piece on that side and connect it to the 5V row.
- Ok, now with the TIP 120, place it so the smooth side that doesn't say TIP 120 is facing towards the two-row side of the board. Make sure the TIP 120 three pieces are connected to their own rows
- Place the other piece of the Dioxide in the row with the middle pin of the TIP 120
- Now if you're looking at the TIP 120 like this:



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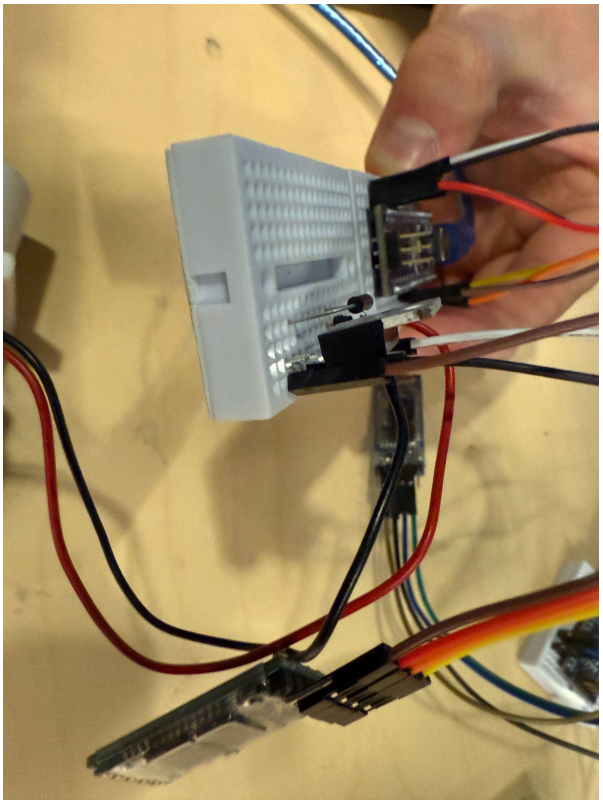
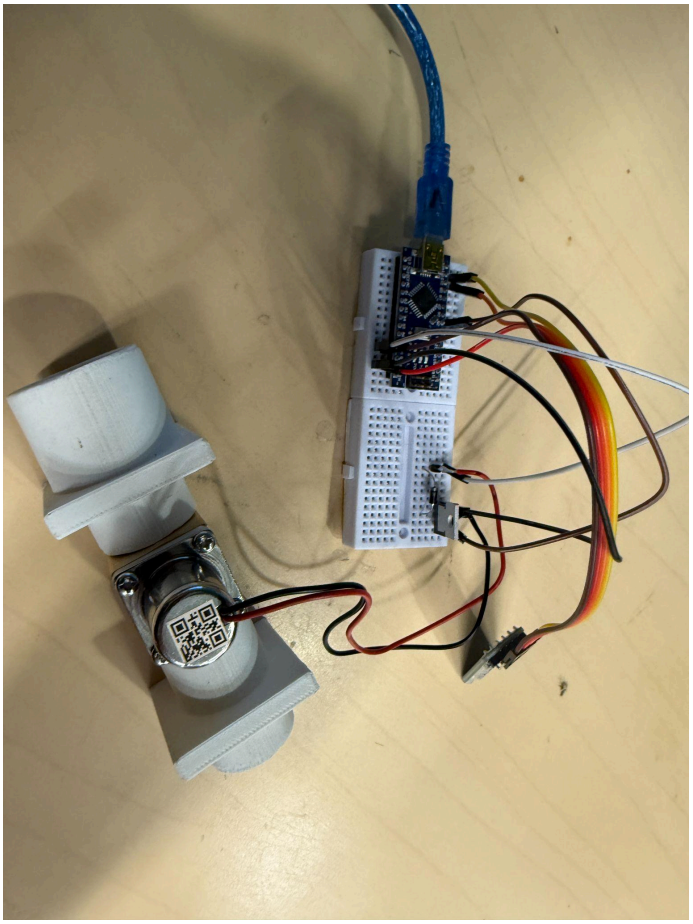
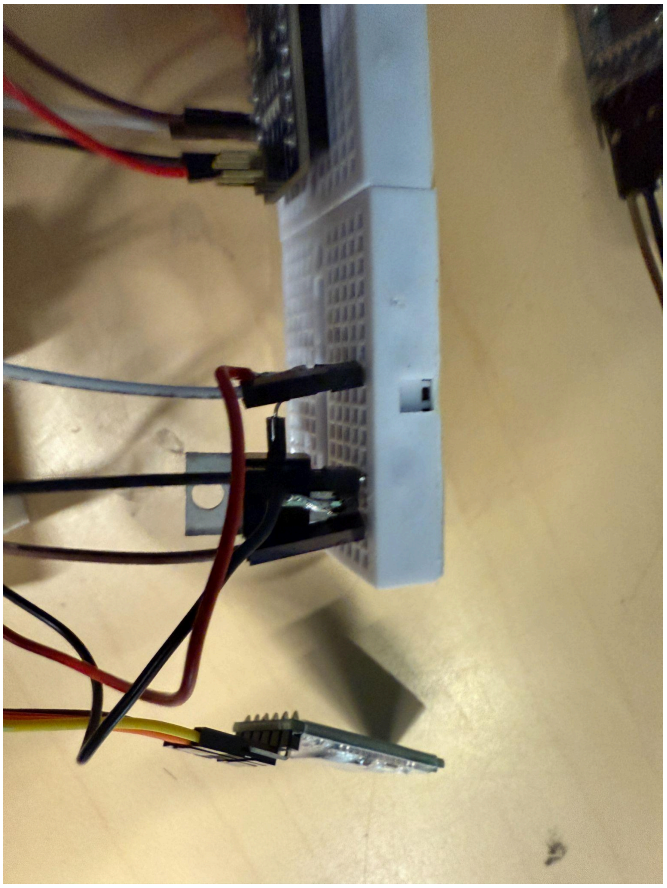
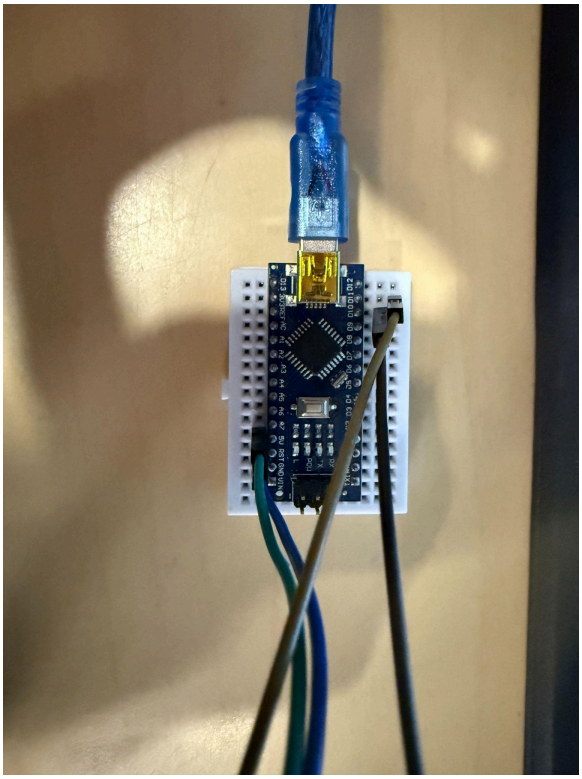
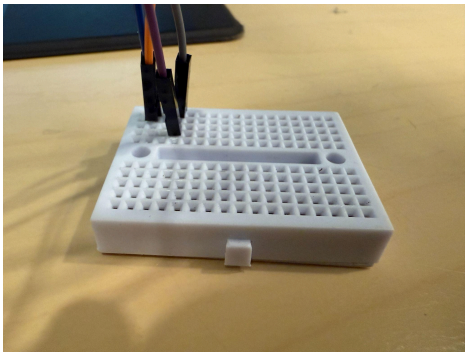
- Place the Black wire of the Solenoid to pin 2 of the TIP 120 Same row as the Diode
- Use another male-to-male wire to connect from row 1 of the TIP 120 to pin D5 on the Nano row
- Now use another male-to-male wire to connect the GND row of the Nano to Pin 3 of the TIP 120

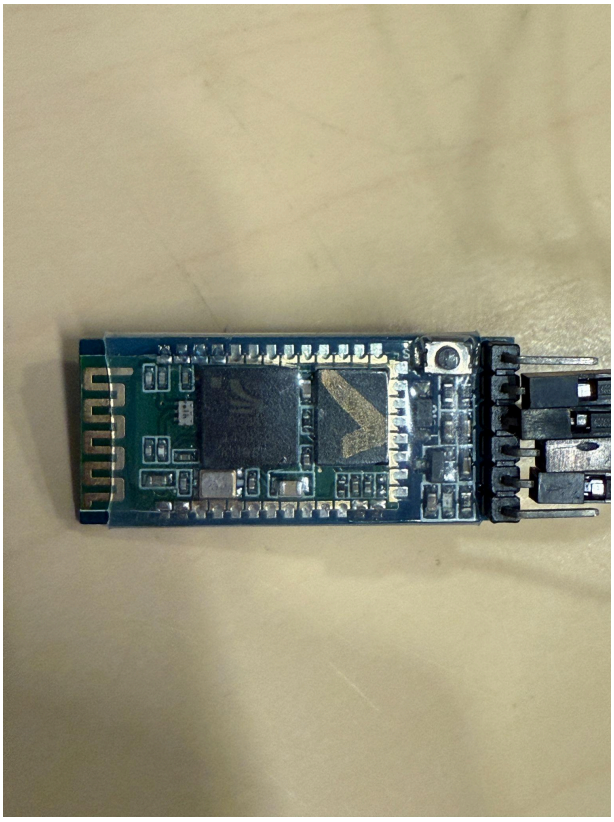












- Plug the nano into your computer, and with everything wired correctly, the board should power up, and the Bluetooth module should be on again
- If this is the case, we can set up the Bluetooth module again
- Return to the Arduino IDE. Use the same code as before and upload it to the new nano
- Unplug it, press the button on the Bluetooth module again, keep holding as you plug it back in, it should be blinking once every two to three seconds again
- You should see “----- HC-05 AT Command Interface -----
- Make sure HC-05 is in AT mode (LED blinking slowly)
- Enter AT commands in the Serial Monitor
- For example: AT, AT+VERSION, AT+NAME, etc.” In the serial monitor again

- Type AT+ROLE=0
- You should then receive
- Response:
- +ROLE:0
- OK
- If not, try again until you get it. Sometimes you'll see ERROR(0) just type it again
- Once you see that type AT+ADDR?
- You should see something like +ADDR:98d3:32:12345 copy 98d3:32:12345
- Then unplug it, grab your other Arduino with the relay, and hold down the button again as you plug it in, then type AT+BIND=(Place this here 98d3:32:12345)
- Then you should see Ok if it worked. If it did, power both of them up using the battery packs, and you should see them blink really quickly, and then the lights will blink at the same time when connected. If you see this, we are done with the first part
- Replug the Arduino with the relay in and paste the Master Code back in:
- Then click the -> to make sure it saves when it's done uploading, unplug the Arduino, and create a new file in the IDE Click File -> New Sketch
- Then plug your other Arduino, the one with the solenoid, into your computer and paste the Slave Code
- Unplug when you're done uploading it

- Step 14: Both Bluetooth Modules are set Now it's bucket time, grab the 55 gallon buckets
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- Step 15: This is where you may slightly vary from me in directions, as I only have two buckets, just repeat the steps for any additional buckets.
- Step 16: Bucket one on the lid around one of the holes, cut a 6” by 5” inch hole on top, this will be for the pump to get inside and the waterwheel to dump the water
- 
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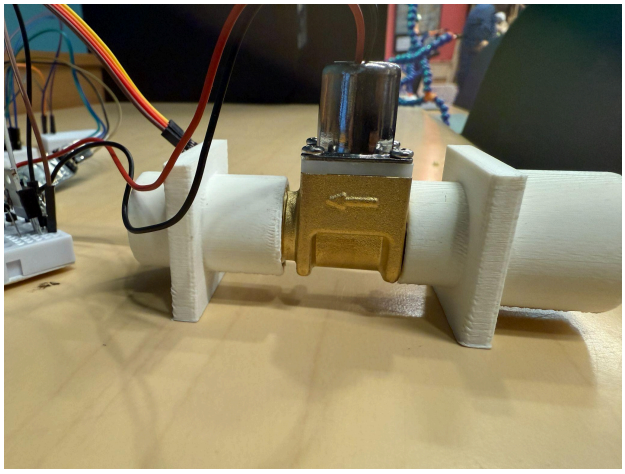
- Step 17: Bucket 2, on the lid around one of the holes cut a 6” by 5” inch hole on top this will be out tube to come inside and to be able to reach inside, then cut a and cut a 1 inch

whole three inches from the bottom of the bucket, then 3D print a piece that can fit inside that one inch hole for the adapter to fit on make the outside diameter equal to 1.25in so the adapter works.

- Step 18: Open this link https://cad.onshape.com/documents/fc32e2dd5568f45e175a29fa/w/2282226ec02c83319e4ff951/e/dd64b6f213658acab3d5535a?renderMode=0&uiState=67fea9e19dad5e19b732c91b, 3D Print(1 Barrel to pipe Adapter, 1 Brett Doesn't Fit Screw, 1 Solenoid to Pipe, and 1 Pipe to Water Wheel)
- Step 19: Connect Barrel to Pipe Adapter to Bucket, Then with the other end connect it to the Brett doesn't fit screw and then the other side of that adapter the solenoid on the opposite side of where the arrow is pointing. Then connect the solenoid to the pipe adapter part to the other end of the solenoid, then the other end to the pipe.



- Step 20: Cut the pipe to my height from barrel to barrel was 30 ft so I cut two 30 ft pipes Do whatever your height is
- Step 21: For the pipe that is connected to the solenoid, connect it to the water wheel using the adapter. Place the water wheel over the opening of the bottom bucket for the water to go there.

- Step 22: Next, use the 3/4 in - 1-3/4 in Stainless Steel Hose Clamp (10-Pack) to connect one end of the second pipe to the pump, and then place the other end of the pipe in the barrel.
- Step 23: Now that all the pipes and electronics are connected, grab the solar panel and battery
- Step 24: Wire the solar panel to the battery so the solar panel charges the battery using the Amazon steps.
- Step 25: Next, carefully attach a wire which will connect to the power of the battery and solder it to the power wire of the pump. Once both cables are soldered. Hold tight
- Step 26: Next step, grab the relay, unscrew the NC and COM, connect the pump ground wire to the NC and the battery wire to the COM. Now attach the negative very carefully to the battery, and then only after the negative is connected, connect the positive to the battery.
- Step 27: Ensure the relay is correctly controlling the pump. If so, then we are done and only have a few simple housekeeping steps.
- Step 28: Lastly, connect the solar panels to the battery packs and the battery packs to the arduinos the system is complete.
- PS If there are any leaks on the system, use 3/4 in.- 1-3/4 in. Stainless Steel Hose Clamp (10-Pack) and the plumbers tape to address them

- Operation Instructions, step-by-step, w/ Images
    - Step 1: For the housekeeping setting, make sure all the electronics are in their protective cases to prevent them from being fried by the water
    - Step 2: Ensure the pump's relay turns off the pump if there isn't enough water to submerge
    - Step 3: Ensure the pump soldier is protected with electrical tape to prevent sparks
    - Step 4: Create code for the relay system that connects to a new sensor that turns off the pump prior to the pump being submerged
    - Step 5: Add a battery level checker to the battery that can communicate with the relay and correctly turn on the relay if the solar energy generated is greater than the usage
    - Step 6: Additionally, add code to the system that will send the open command to the solenoid to open if the battery level falls below a predetermined level
    - Step 7: Use a multimeter to measure how much power is generated by the water wheel
    - Step 8: Check to make sure the system works correctly. If so, you're good to go

Code Link

- https://github.com/Hacking-The-Apocalypse/2025-Spring-GravityBatteryGroup
    - There are Three Files:
        Bluetooth Module SetUp
        Master Code

Slave Code

Future Development: (notes on what future developers might focus on)

- Considerations for the future
    - Build a water tower that is all one system, as opposed to using balconies and roofs.
    - Add the sensor to the battery for the Arduino to correctly divert power and recharge the batteries.
    - Add code to the system to ensure that the Arduinos reliably work independently of human intervention.
    - Add a wattage meter to see how much power is being produced by the sun and by the water wheel.
    - See if you can add multiple water wheels to the system
    - See if you can attach multiple barrels to each other to have max power outage and use the system as a storage system
    - Add solar panels to the top of the system, and add a filter system with UV light to see if the water can be purified throughout the system

Video Link:

https://photos.app.goo.gl/3cGUGZYQxgCwcWFm9 (Water in barrel)
https://photos.app.goo.gl/kbz8nm37BmU1nWWy9 (Bluetooth Setup)
https://photos.app.goo.gl/vyX6HXdBad8n4ZuV6 (Testing Day)

Unrelated Cool Class Photos: