

Electronics:

- [Keyestudio nano CNC shield](#) (\$6)
(WARNING: there are cheaper clones of this board available, but most, if not all, have a known circuit trace error; see [this instructible](#) by Palingenesis for details of the problem and how to repair it.)
- [Arduino Nano 33 IOT](#) (\$18.40)
- (3) [TMC2208 stepper motor drivers](#) (\$13.63 for 4)
- (1) [TB6612 DC motor driver](#) (\$4.95)
- (1) pH meter with isolated ADC board (\$75-165)
(Analog signal amplifier boards are cheaper but *do not work* for this project in my experience. I suggest the Atlas Scientific [EZO pH circuit](#) and [isolated carrier board](#) paired with a cheap [Grove pH probe](#). However, you might consider the convenience of purchasing a [full kit from Atlas](#), which comes with pH calibration solutions.)
- (1) 5V linear regulator rated for at least 1 amp sustained load (<\$1)
- Heatsink for above linear regulator
(This can be either a proper mini aluminum finned heatsink or just a spare piece of metal attached via the mounting screw.)
- (3) NEMA 17 stepper motors (\$2-8 each)
(I recommend searching eBay for used motor sets as people often sell their old NEMA motors for very low prices after upgrading their 3D printers; I got my set for this project for \$9.)
- (3) NEMA motor cables, unless included with the motors you purchase
- (1) [24mm DC motor](#) (\$1.95)
- Assorted jumper wires, female-female and female-male
- (1) small piece of perfboard/protoboard (optional)
- (1) panel mount DC jack, suitable for 11-12mm hole

Screws and hardware:

- (3) M3 x 10 grub screws
- (18) M4 x 10 screws
- (13) M3 x 6 screws
- (12) M3 x 12 screws
- (11) M3 x 5 x 4 threaded inserts
- (6) M4 x 6 x 6 threaded inserts
- (12) M4 x 6 x 4 threaded inserts
- (11) M3 x 6mm standoffs
(I suggest using nylon rather than metal ones here, as you can use flush cutters to shorten the threaded end if it sticks out the back of the casing.)
- (4) 2x6mm neodymium magnets
- (9) HK0408 needle roller bearings
- (9) 4mm x 14mm steel dowels

Tubing:

- 0.8mm ID/4mm OD soft silicone tubing, ½ metre
- 1.6mm ID/4mm OD soft silicone tubing, distance to reach skimmer/waste cup plus distance to reach tank
- (1) [M-3ALU-3 fitting](#) (\$3.33)

Manufacturing materials:

- PETG filament
- (2) 600x300mm sheets of 4mm thick acrylic

Consumables:

- Calibration buffers for pH 4, 7, and 10, unless you bought the full Atlas kit listed in the electronics section above.