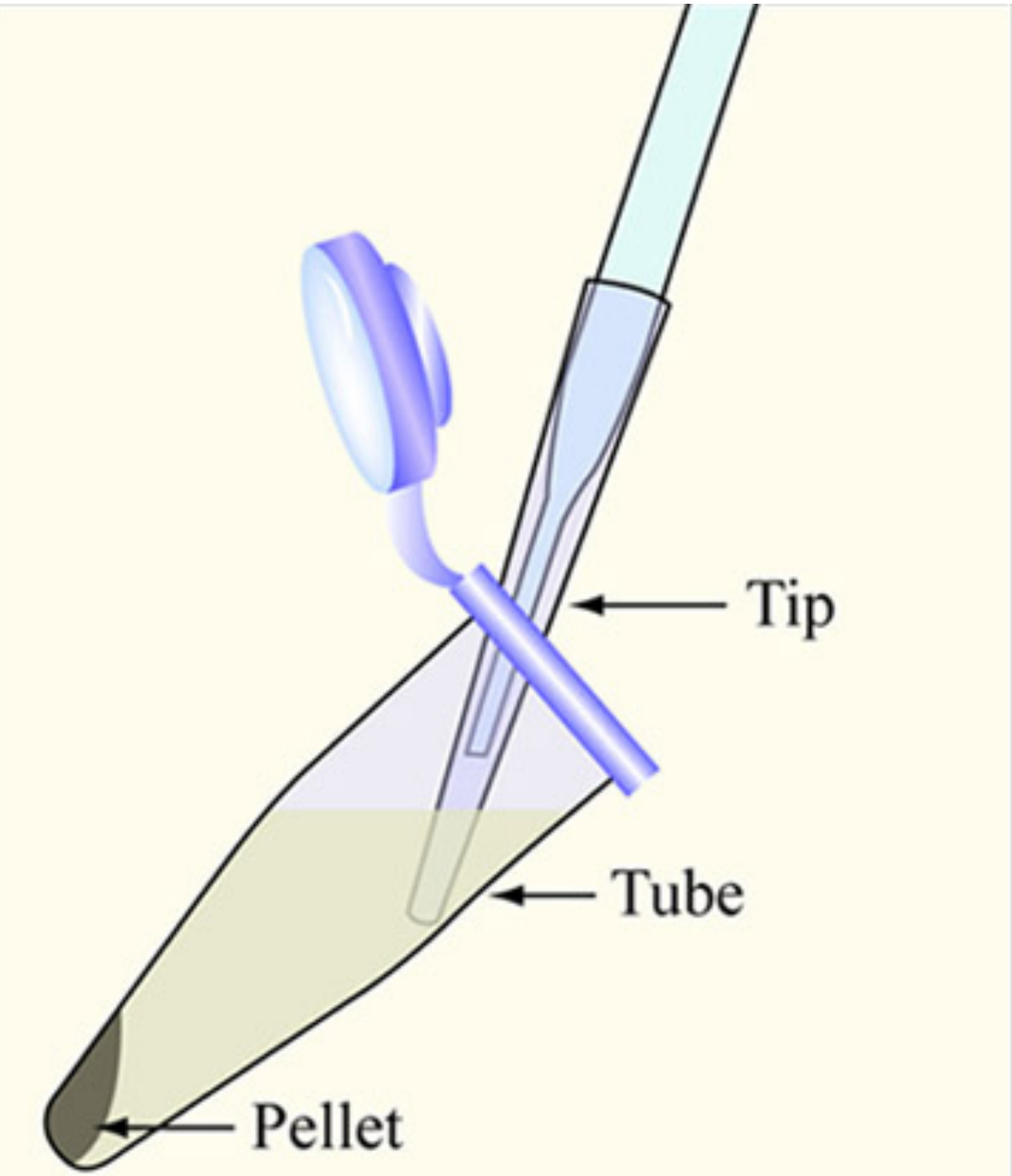
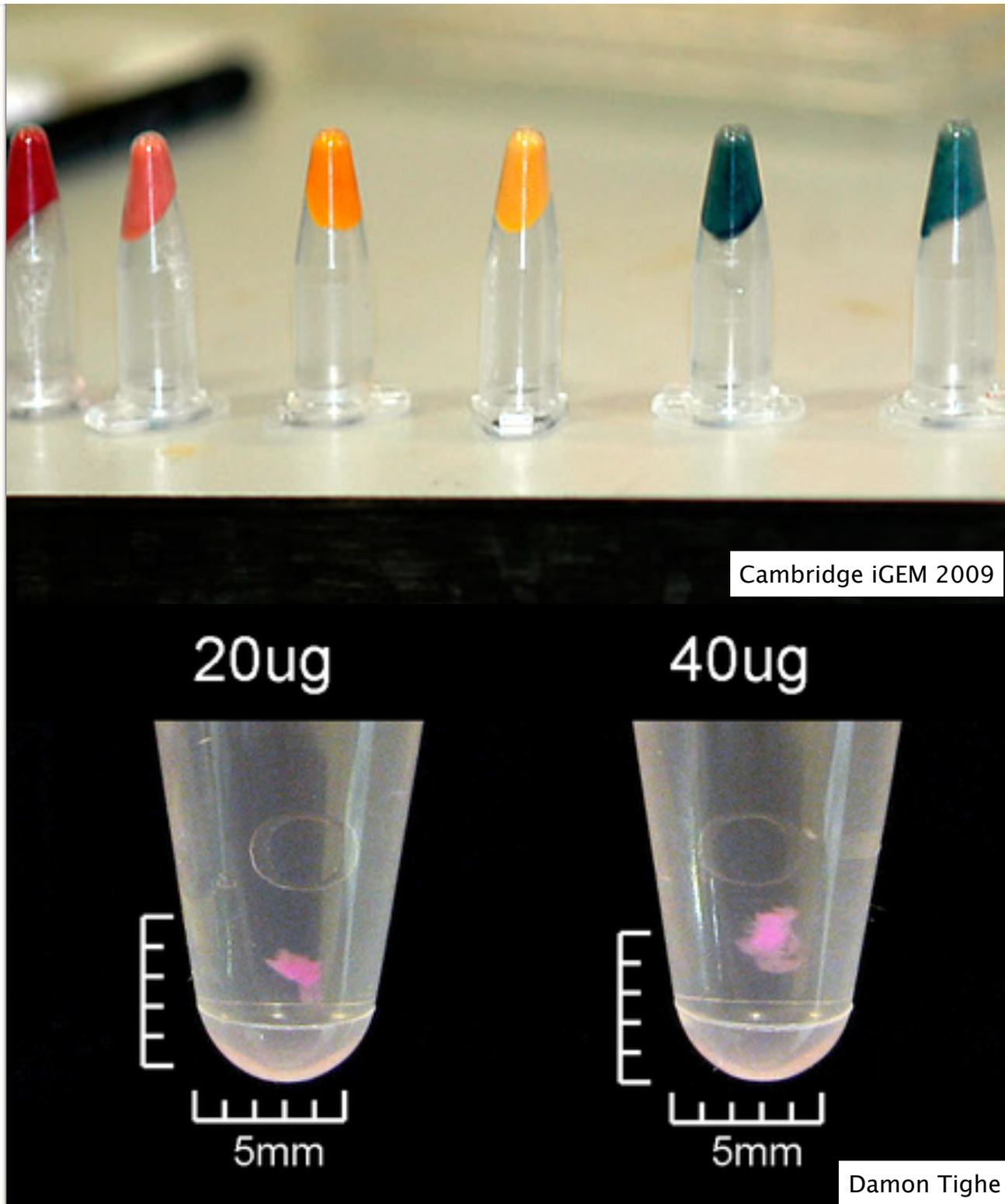
waag
wetlab amsterdam

BioHack Academy
Centrifuge Design

Centrifugation



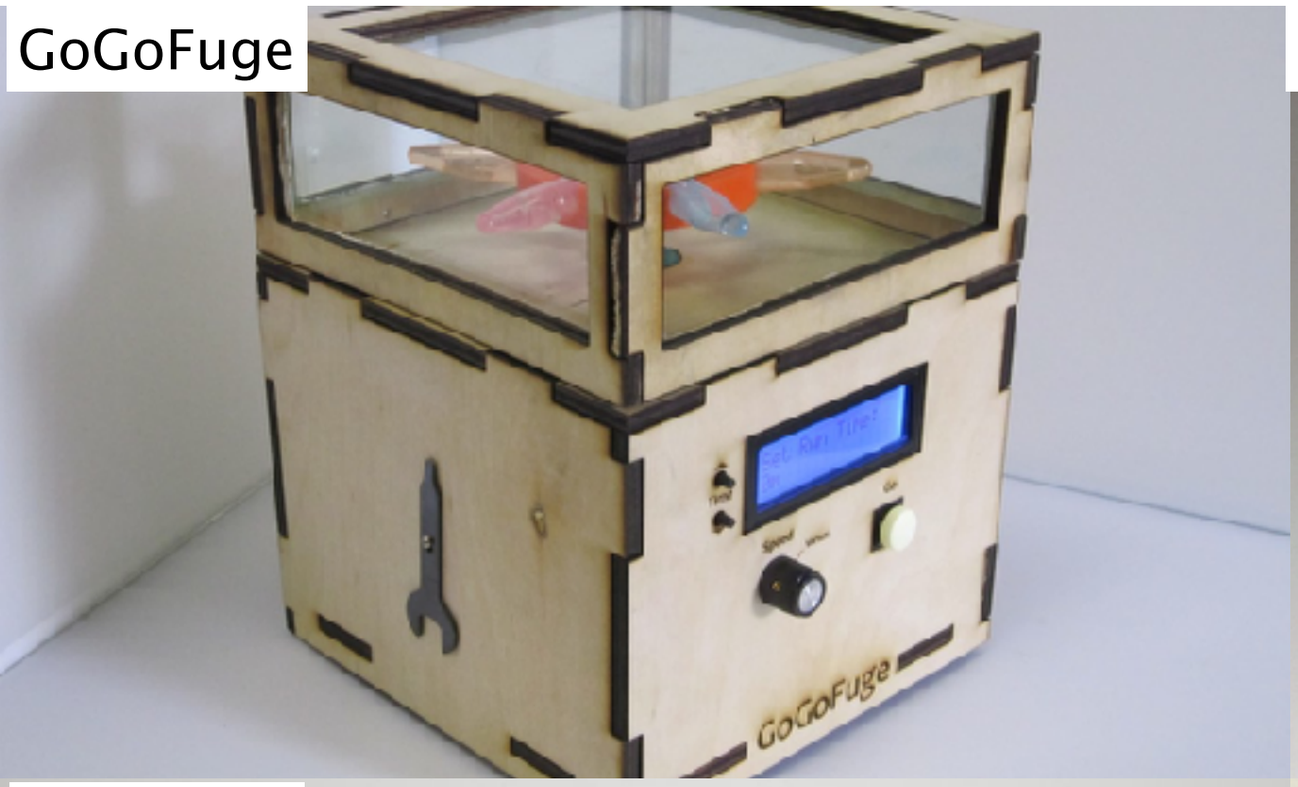


Industry standards

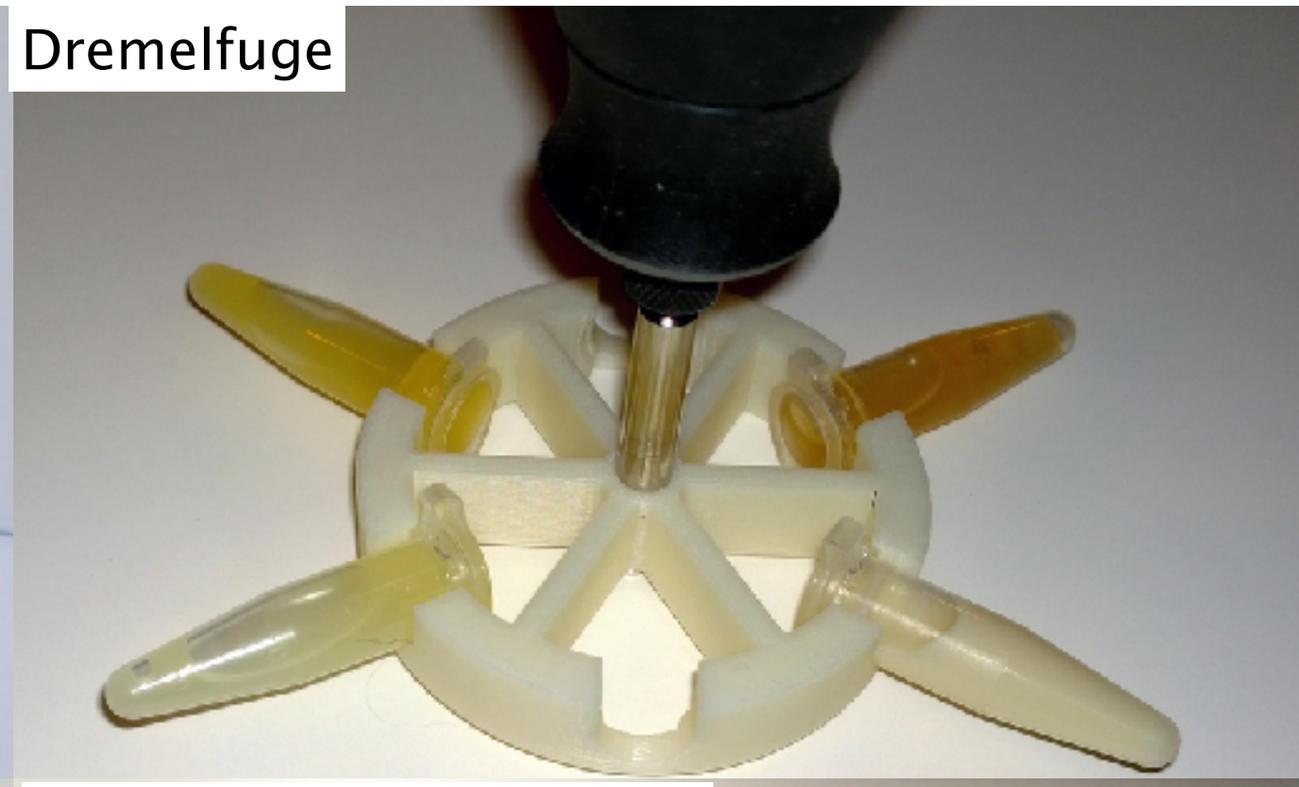
Magnus Manske - CC-BY 1.0

Centrifuge hacks

GoGoFuge

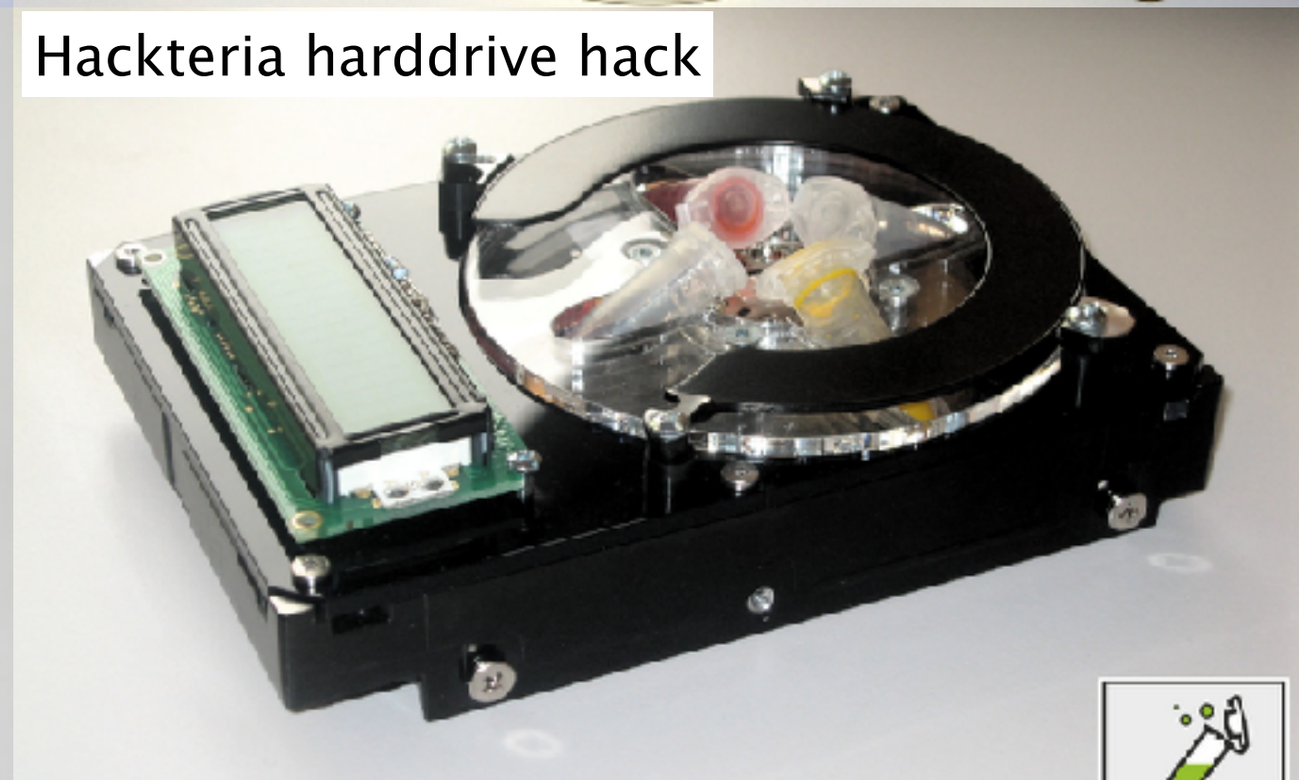


Dremelfuge



OpenFuge

Hackteria harddrive hack

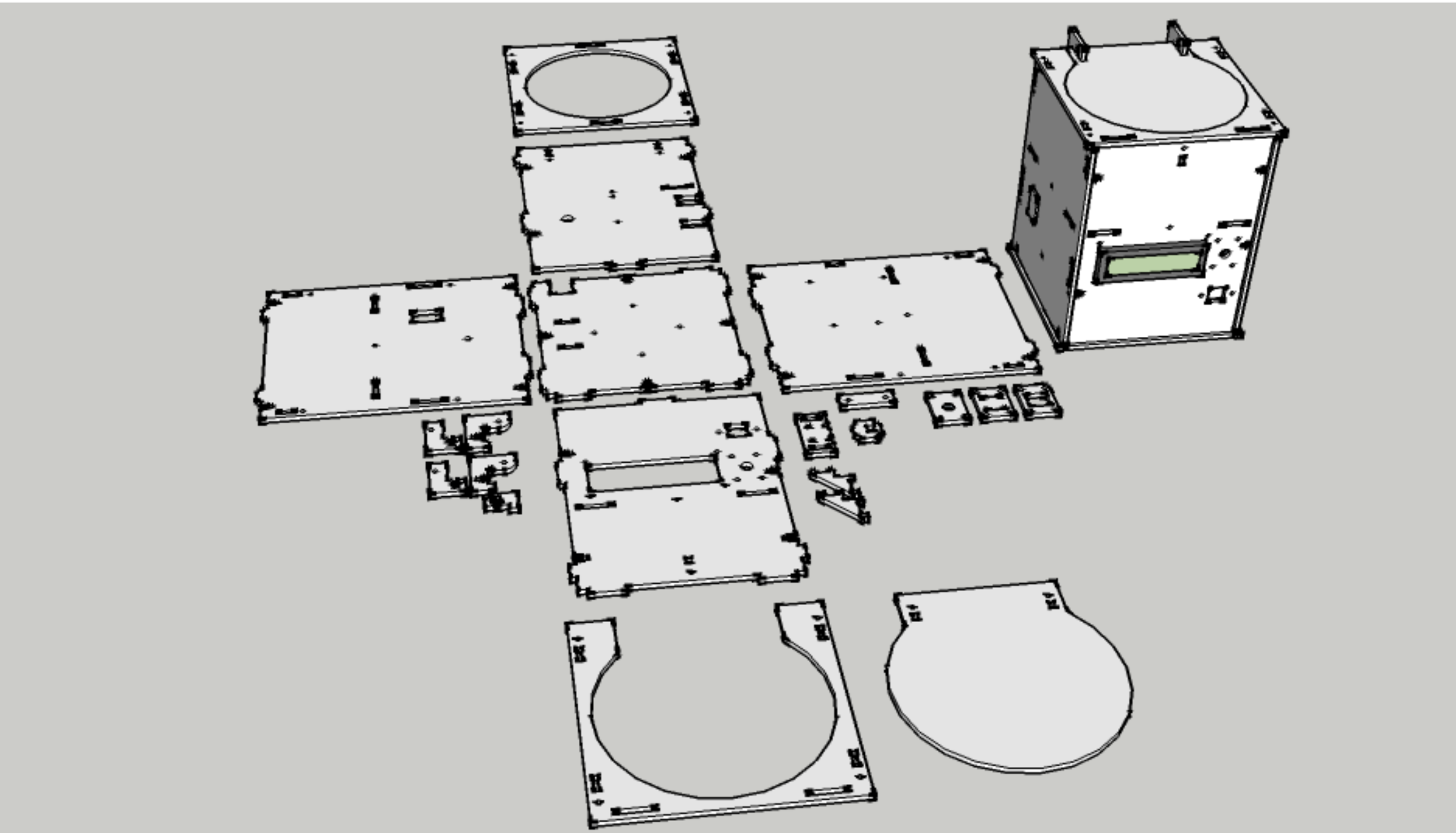


Design constrains

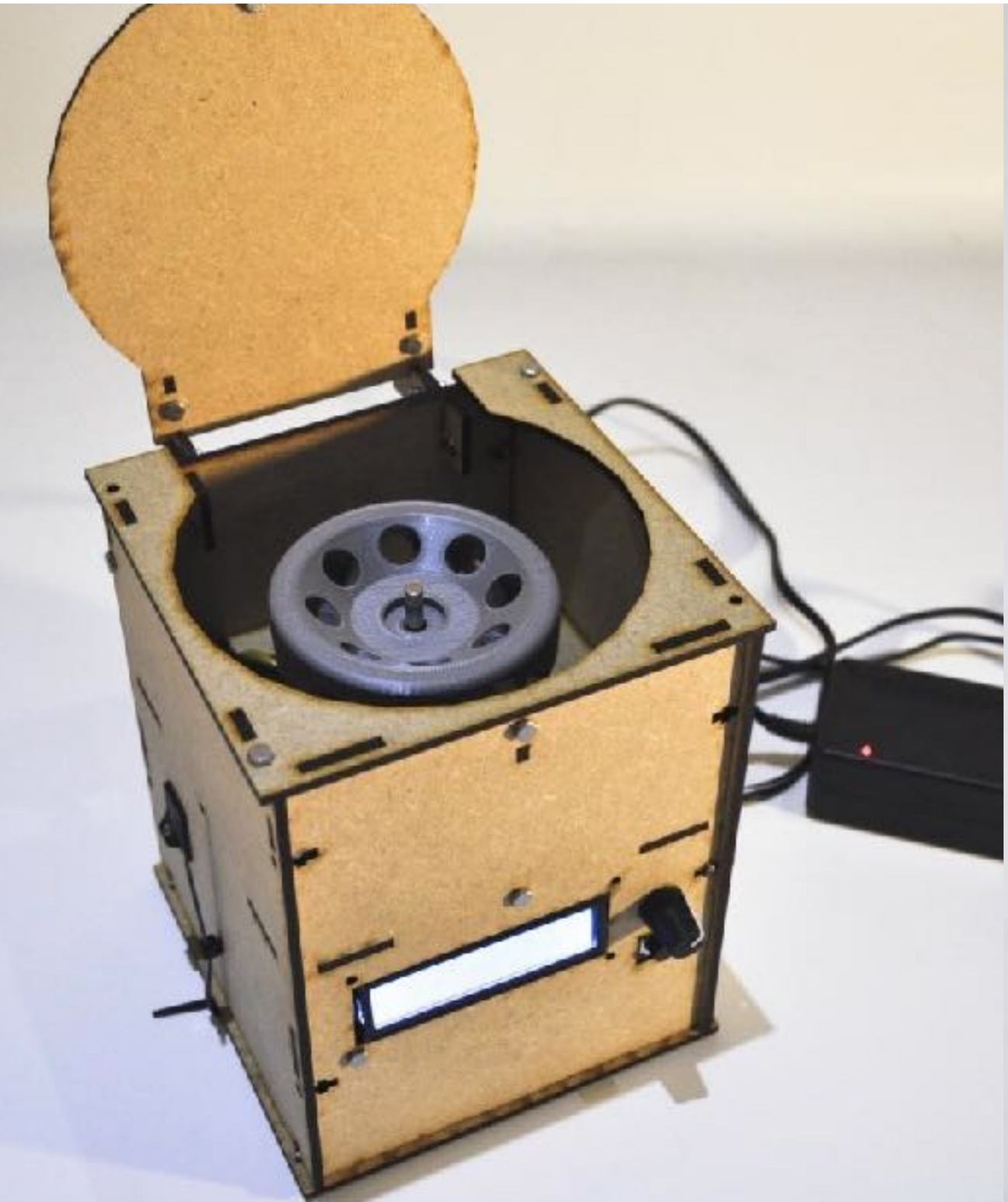
Notice

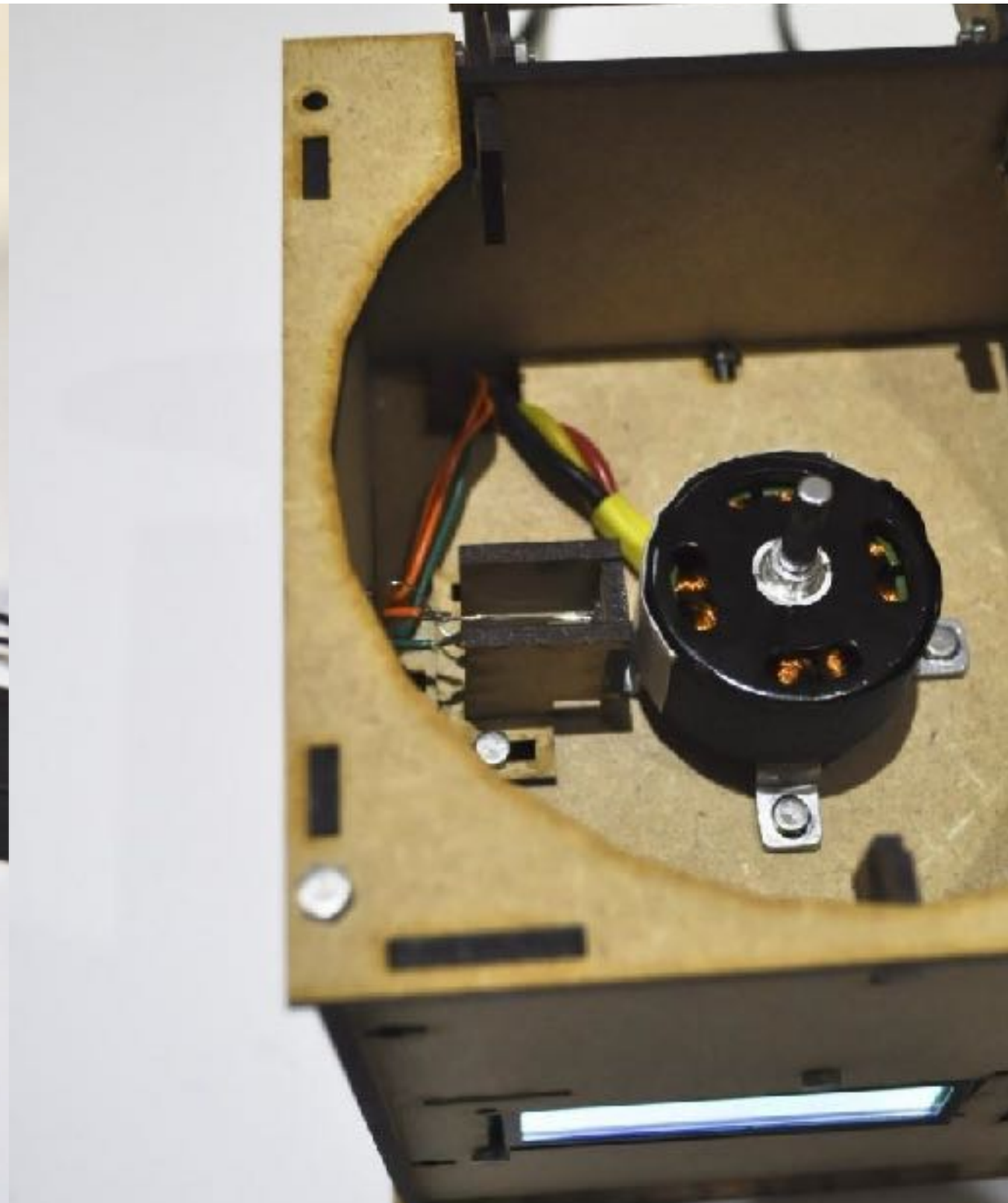
- NEVER test your centrifuge with a rotor attached

BioHack Academy design



Some pictures





Bill of Materials

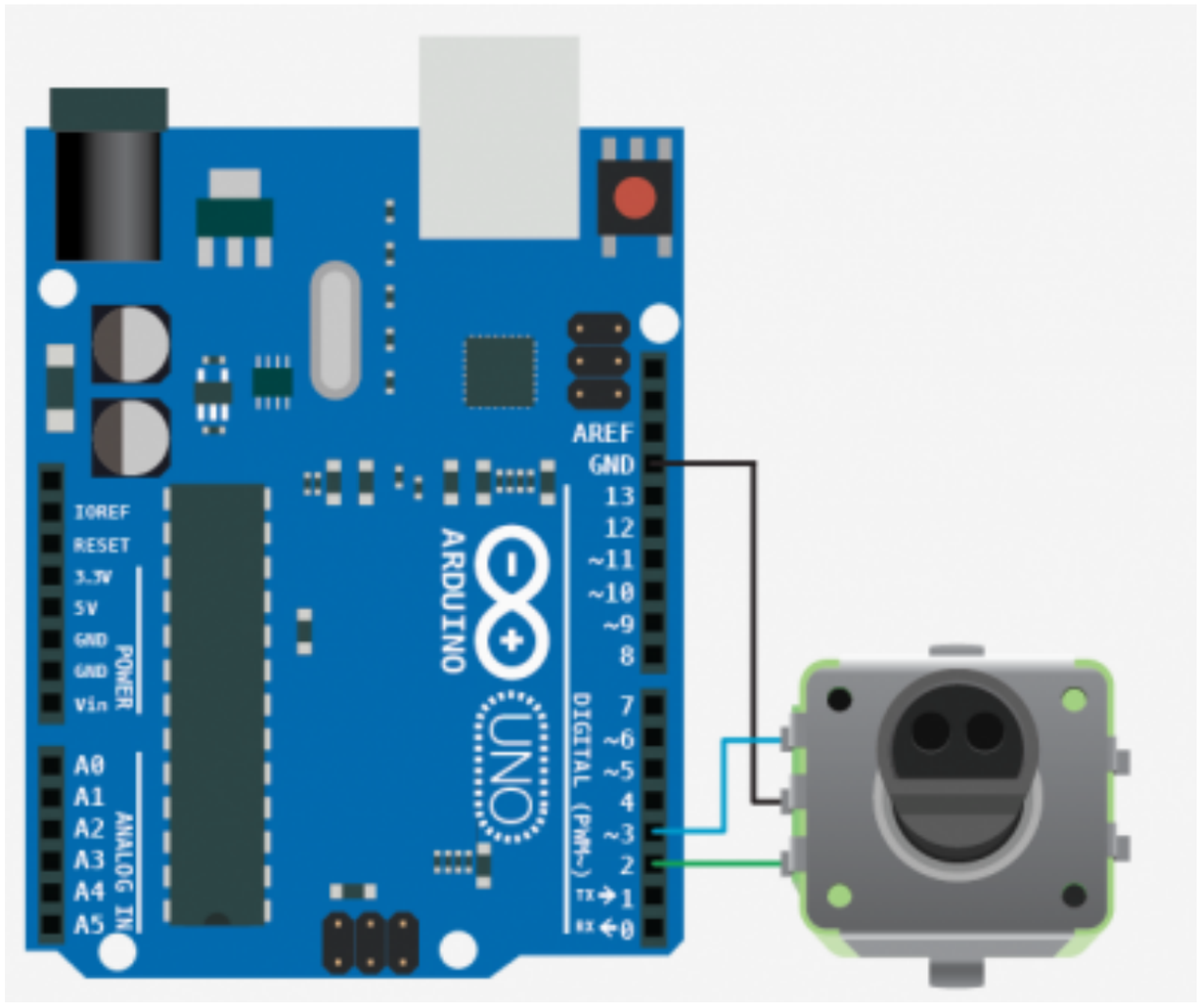
No	Amount	Description	Supplier NL	Cost
1	1	DC Brushless motor 800 RPM/V & Electronic Speed Controller	HobbyKing	15.22
2	1	3.5mm connector	HobbyKing	3.14
3	1	Rotary encoder	Farnell, iPrototype, EOO	0.42
4	1	Knob	Farnell	0.23
5	1	Power switch	Farnell, iPrototype	0.71
6	1	DC power jack	Farnell, EOO	0.85
7	1	12V 5A Power supply	Farnell, EOO	38.13
8	1	Push button	Farnell,iPrototype, Sparkfun	0.47
9	1	10K resistor	Farnell, EOO	0.03
10	4	Rubber feet	Conrad	0.08
11	1	Infrared sensor	Farnell	1.70
12	1	6.8 KOhm resistor	Farnell	0.02
13	1	220 Ohm resistor	Farnell	0.02
16	1	I2C LCD display	iPrototype, Hackerstore	8.95
17	2	10K resistor	Farnell, EOO	0.6
18	2	10nF capacitor	Farnell, iPrototype, EOO	0.14
19	2	100nF capacitor	Farnell, EOO	0.14
20	1	Breadboard	Farnell. iPrototype	2.56

Motor

- Brushless
  - 810 KV
  - RPM / V = 810
  - 12V, so 9720 RPM
- ESC
  - power limit
  - voltage regulator

24 steps rotary encoder

- Rotates infinitely
- 3 pins:
  - GND
  - State1
  - State2
    - 2 bits:
      - 00
      - 01
      - 11
      - 10
- Interrupt pins
  - attachInterrupt()
- Demo code in Syllabus

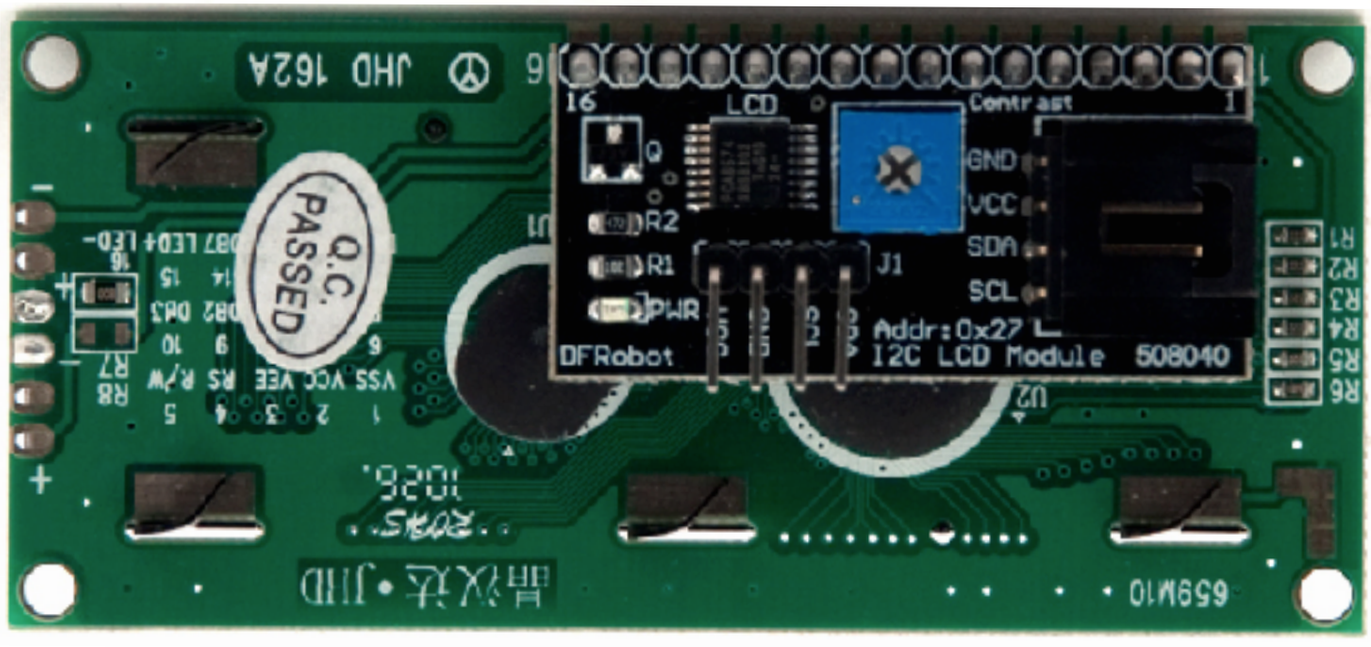


I2C Display

- Arduino I2C ports
  - SLC -> A5
  - SDA -> A4

- Libraries
  - Wire
  - LiquidCrystal_I2C

- Demo code in Syllabus



Heavy weight

- Stabilising the machine

Infrared sensor

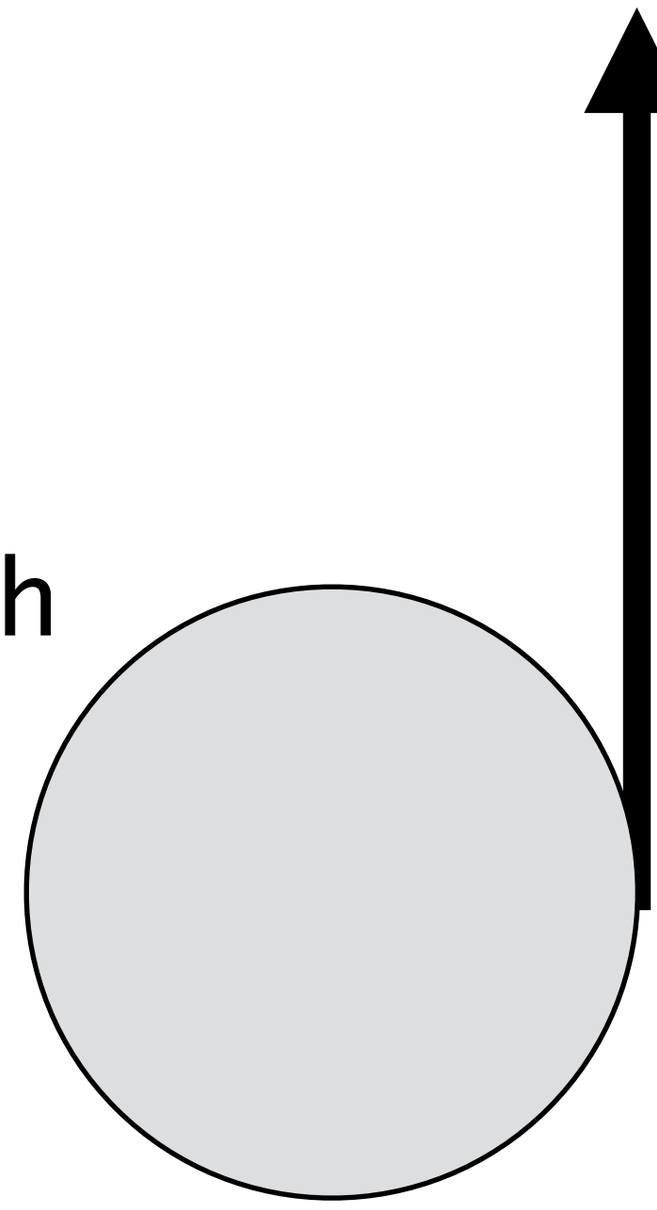
- Emitter
- Detector

- pulseIn() function
  - http://arduino.cc/en/Reference/pulseIn

Roller coaster

Centrifugal force

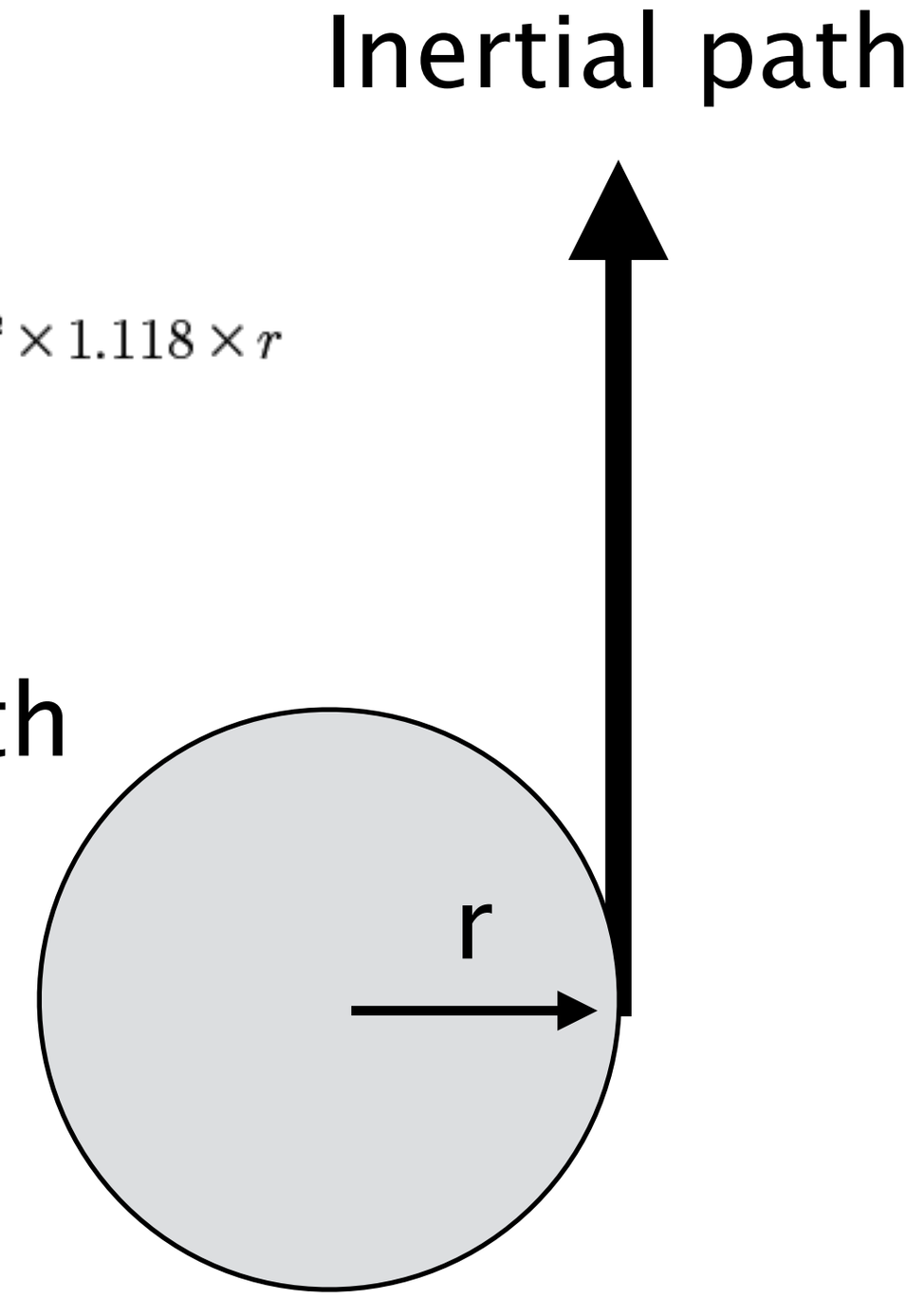
Inertial path



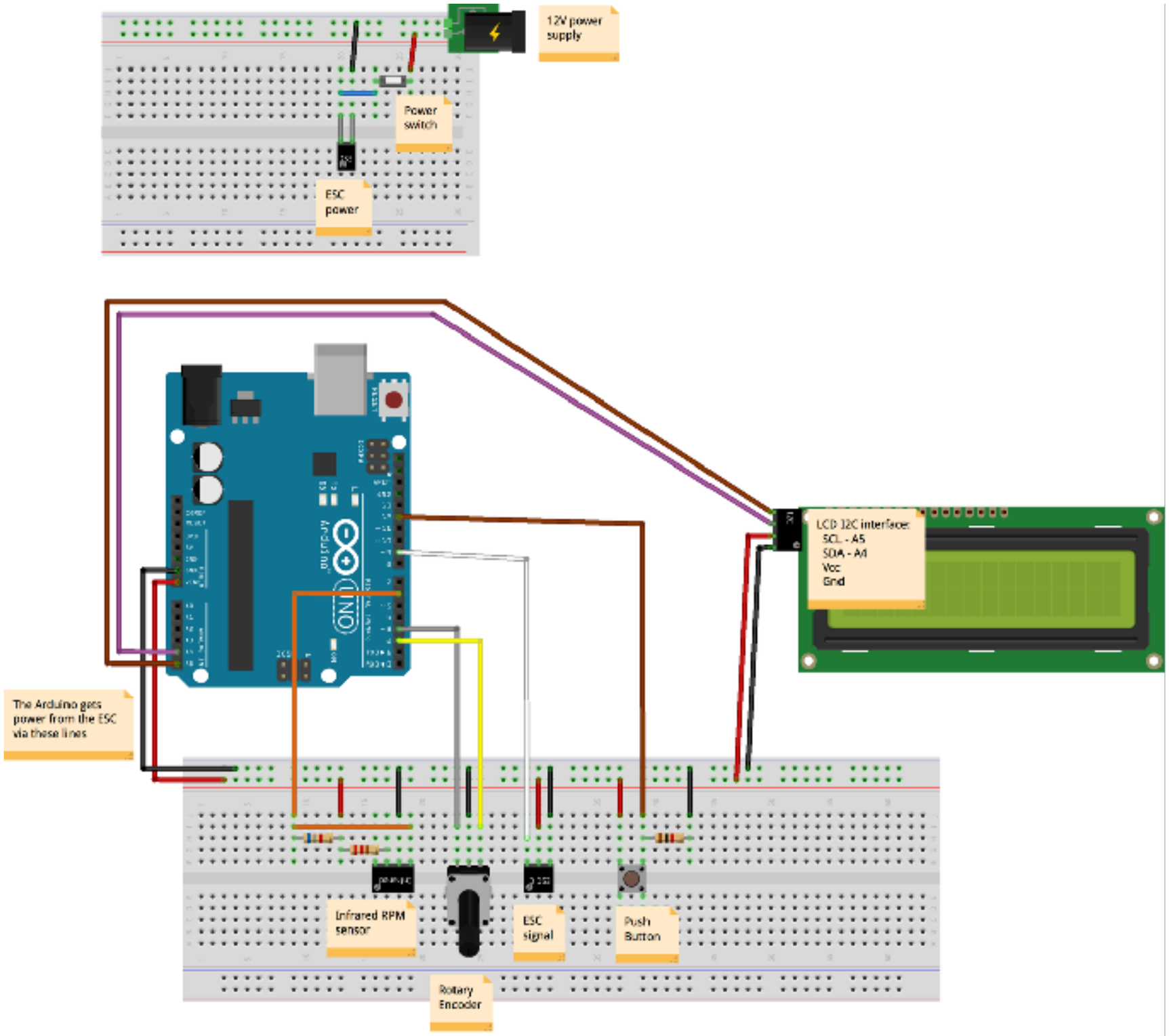
Circular path

Centrifugal force

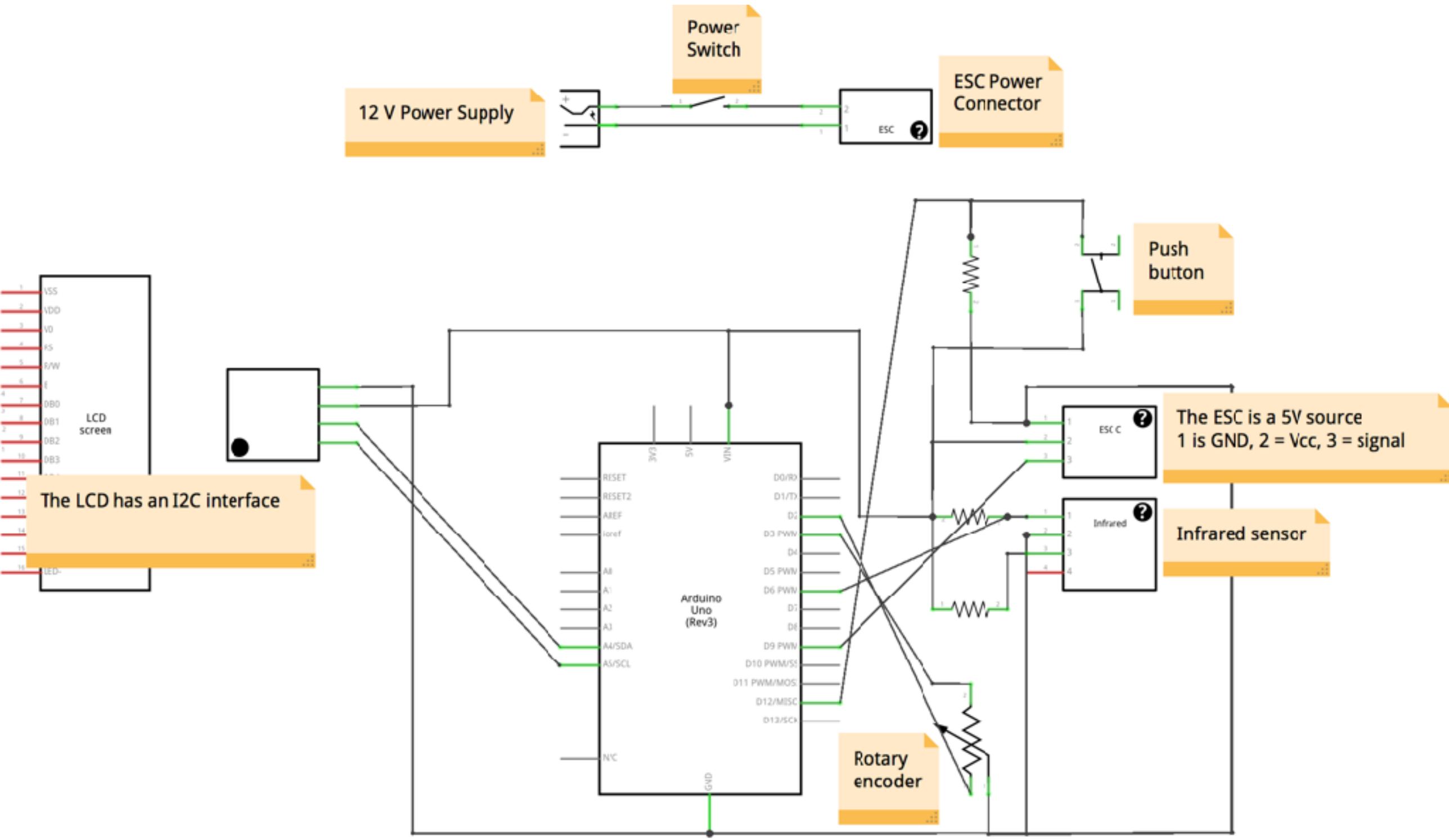
$$G\ force = (\frac{RPM}{1.000})^2 \times 1.118 \times r$$



Wiring


12V power supply
Power switch
ESC power
The Arduino gets power from the ESC via these lines
LCD I2C interface:
SCL - A5
SDA - A4
Vcc
Gnd
Infrared RPM sensor
ESC signal
Push Button
Rotary Encoder
fritzing

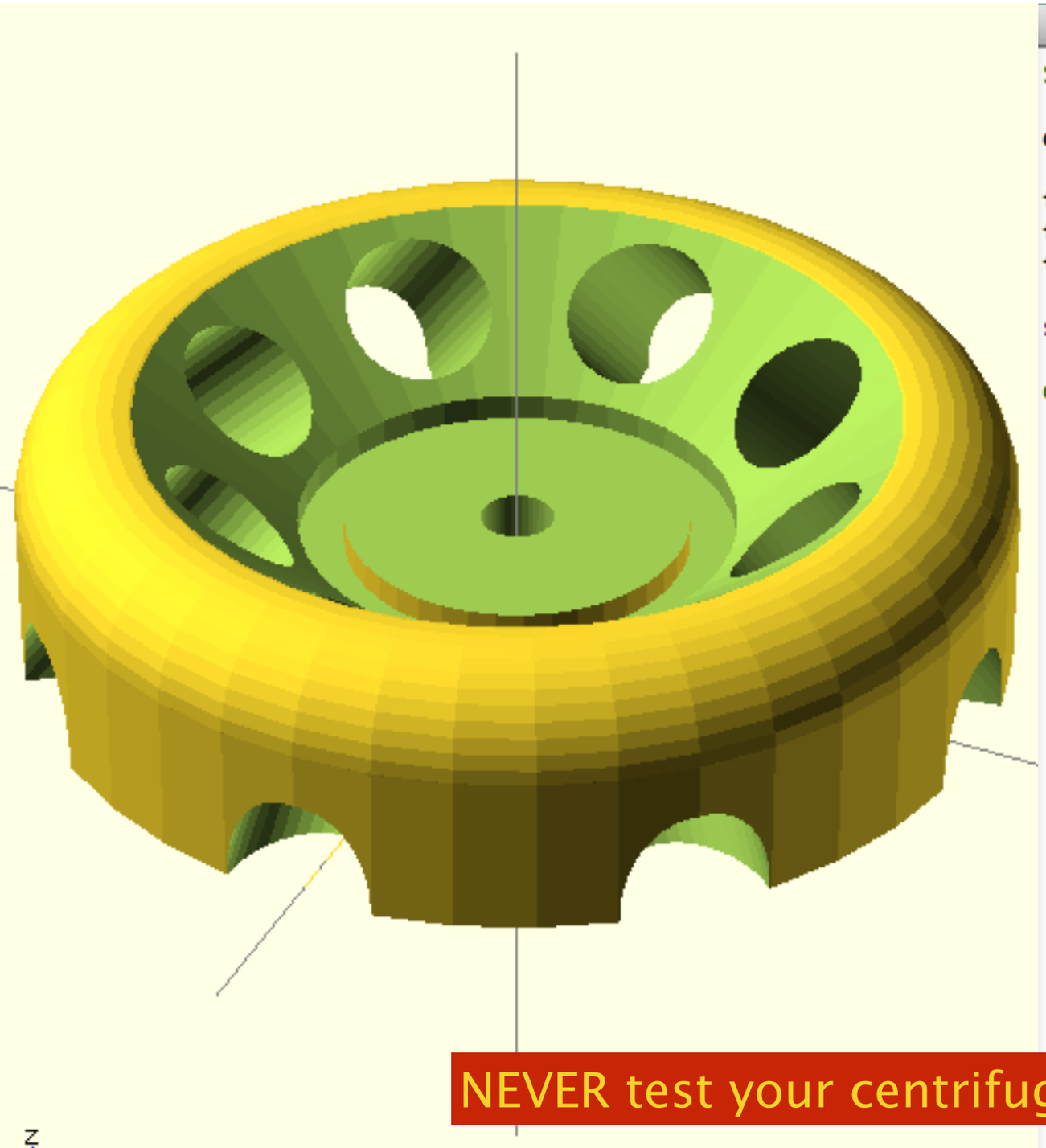
Circuit scheme



Code tutorials

- Rotary encoder
  - http://bildr.org/2012/08/rotary-encoder-arduino/
- I2C LCD
  - http://playground.arduino.cc/Code/LCDi2c
- Infrared sensor
  - http://bildr.org/2011/03/various-proximity-sensors-arduino/
- Arduino + Electronic Speed Controller
  - http://www.instructables.com/id/ESC-Programming-on-Arduino-Hobbyking-ESC/

Rotor



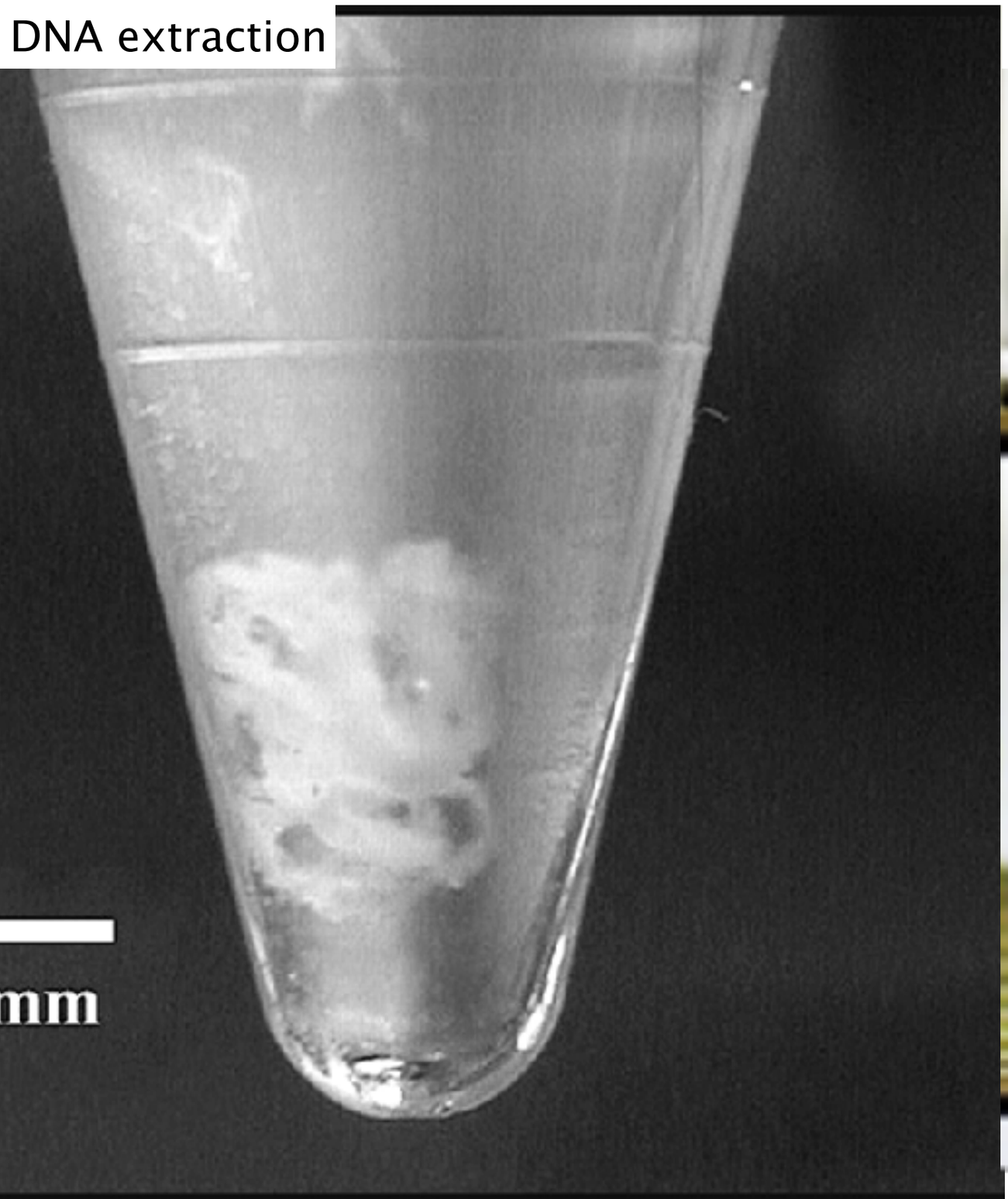
OpenSCAD – 8 Place Rotor

```
$fn=40; // resolution of the arcs

axis_radius = 0.275; // radius of the motor shaft

tube_radius = 0.575; // inner radius of the tube holders
tube_angle = 45; // angle in the rotor
tube_pos = 4.75; // position of tube holders

scale([10,10,10]) { // cm to mm scaling

difference () { // substract tube holders from outer ring

    difference () { // substract inner groove

        difference() { // substract cone from main disk

            union() {
                cylinder (h = 1.25, r=3.75); // main disk part 1
                cylinder (h = 1.9, r=3.25); // main disk part 2

                // smoothen edge torus
                translate([0,0,1.25])
                rotate_extrude(convexity = 10)
                translate([3, 0, 0])
                circle(r = 0.75);
            }

            translate([0,0,1]) // raise cone from bottom
            cylinder (h = 1.1, r1 = 1.65, r2 = 3, center = false); // co

            translate([0,0,-0.1])
            cylinder (h = 1.3, r = axis_radius); // axis
        }

        // groove under tube holders
        translate([0,0,0.8])
        difference() { // ring
```

NEVER test your centrifuge with a rotor attached

Practicals

DNA extraction



Chlorophyll isolation