

3D-Printed Part Assembly Guide

As specified in the ruleset, the Crater, all 4 Antennas, and Earth are completely 3D-Printed. This document serves as an instruction manual detailing how each 3D-Printed part is assembled together. The quantity of each part and the type of screw required to assemble will be specifically mentioned below in the *Screw Table*. Follow the *3D-Printing Guide* provided with the competition ruleset to print all required parts.

Crater

The Crater has 4 Individual parts of which 36 total parts will be required to complete assembly of the crater. See *Table 1* for details on the quantity of description of each required part. Assembly of the Crater requires 32 of *Screw #1*. See *Figure #6* for an assembly animation displaying the appropriate orientation of each part. Once all parts listed in *Table 1* and all hardware is gathered follow the instructions listed as follows:

1. Align part *Lower Rim* and *Upper Rim* by matching the hole labeled “B” in *Figure #1*, 2. Insert 1 of *Screw #1* through hole “B” and fasten. Ensure the screw head is on the interior surface of the crater.
2. Repeat #1 until 16 copies of the part assembled in #1 are acquired.
3. Align part *Lower Rim* and *Flat Area V1* by matching the hole labeled “A” in *Figure #2*, 3. Insert 1 of *Screw #1* through hole “A” and fasten. Ensure the screw head is on the interior surface of the crater.
4. Repeat #3 until part *Flat Area V1* has 4 of part *Lower Rim* fastened to it.
5. Repeat #3,4 for both copies of part *Flat Area V1*.
6. Repeat 3,4,5 substituting part *Flat Area V2* for *Flat Area V1* and *Figure #4* for *Figure #3*.
7. Align each of part *Flat Area V1* by matching hole “E” in *Figure #3*, 5. Insert *Screw #4* through hole “E” and fasten. Ensure that the *Antenna Box* is located inside the crater.
8. Repeat #7 substituting *Flat Area V2* with *Flat Area V1* and *Figure #3* with *Figure #4*.

Table 1		
Part Name	Quantity	Example Figure
Upper Rim	16	<i>Figure #1</i>
Lower Rim	16	<i>Figure #2</i>
Flat Area V1	2	<i>Figure #3</i>
Flat Area V2	2	<i>Figure #4</i>
Antenna Box	1	<i>Figure #5</i>

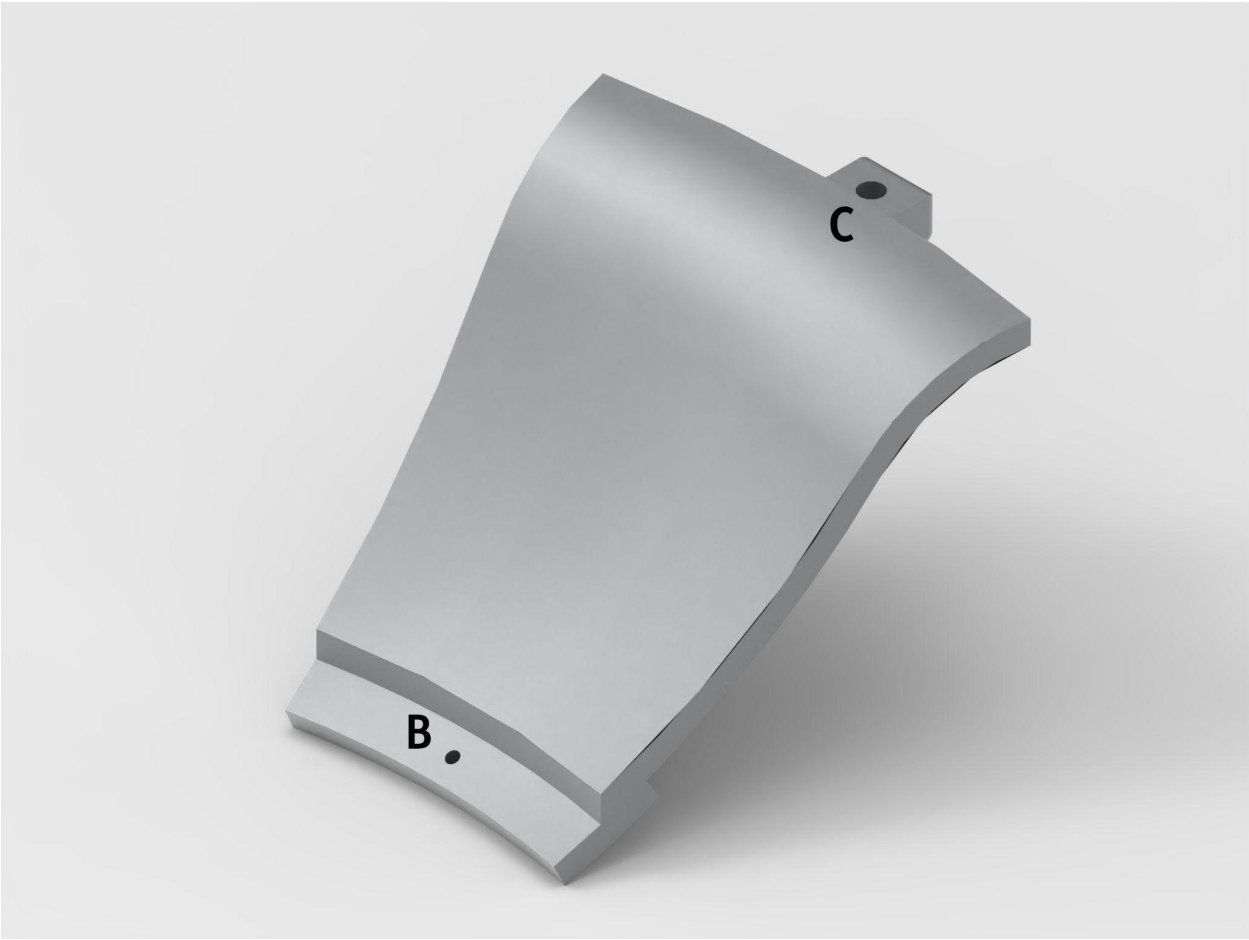


Figure #1 – Crater Upper Rim Piece (16 required)



Figure #2 – Crater Lower Rim Piece (16 required)

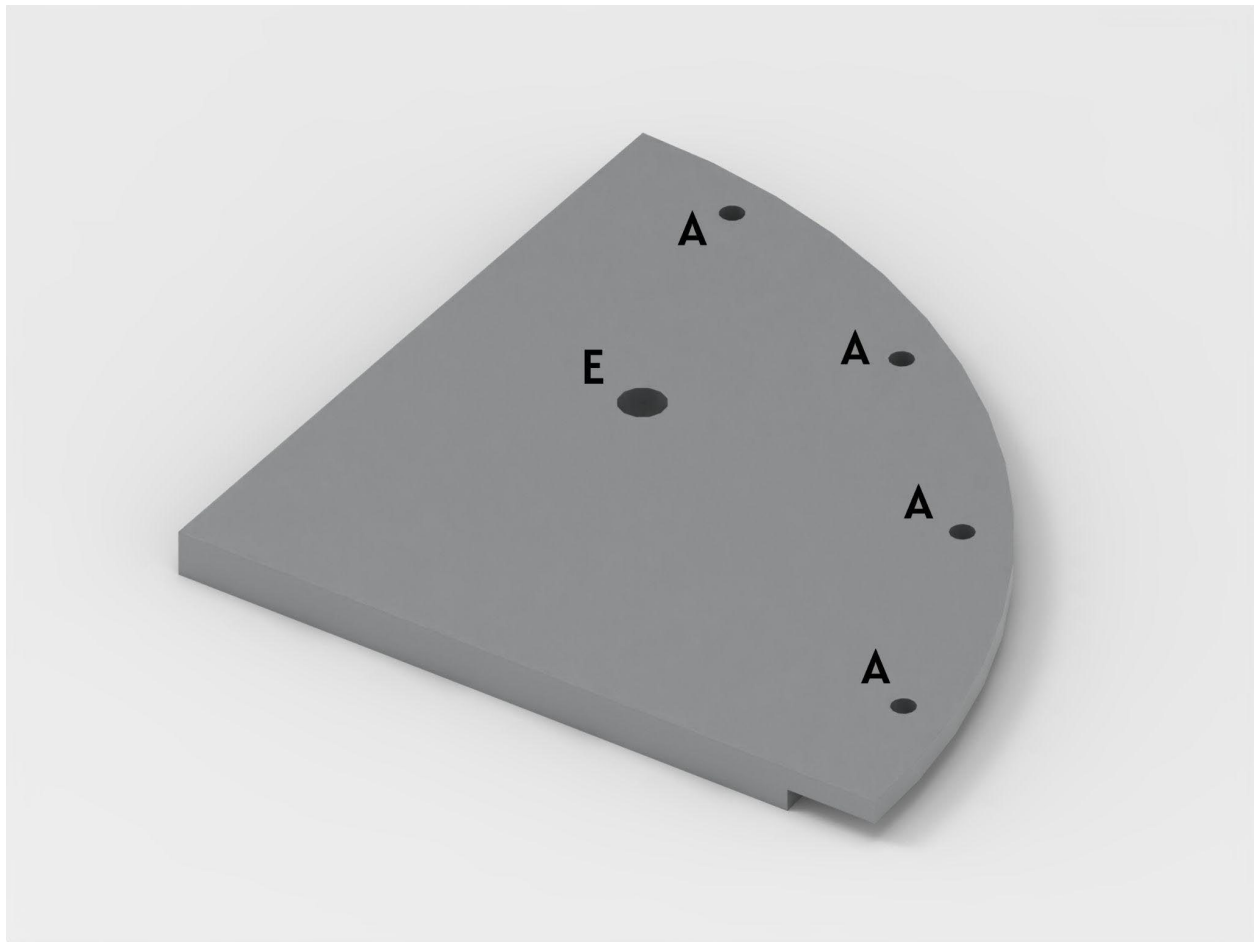


Figure #3 – Crater Base Part V1 (2 required)

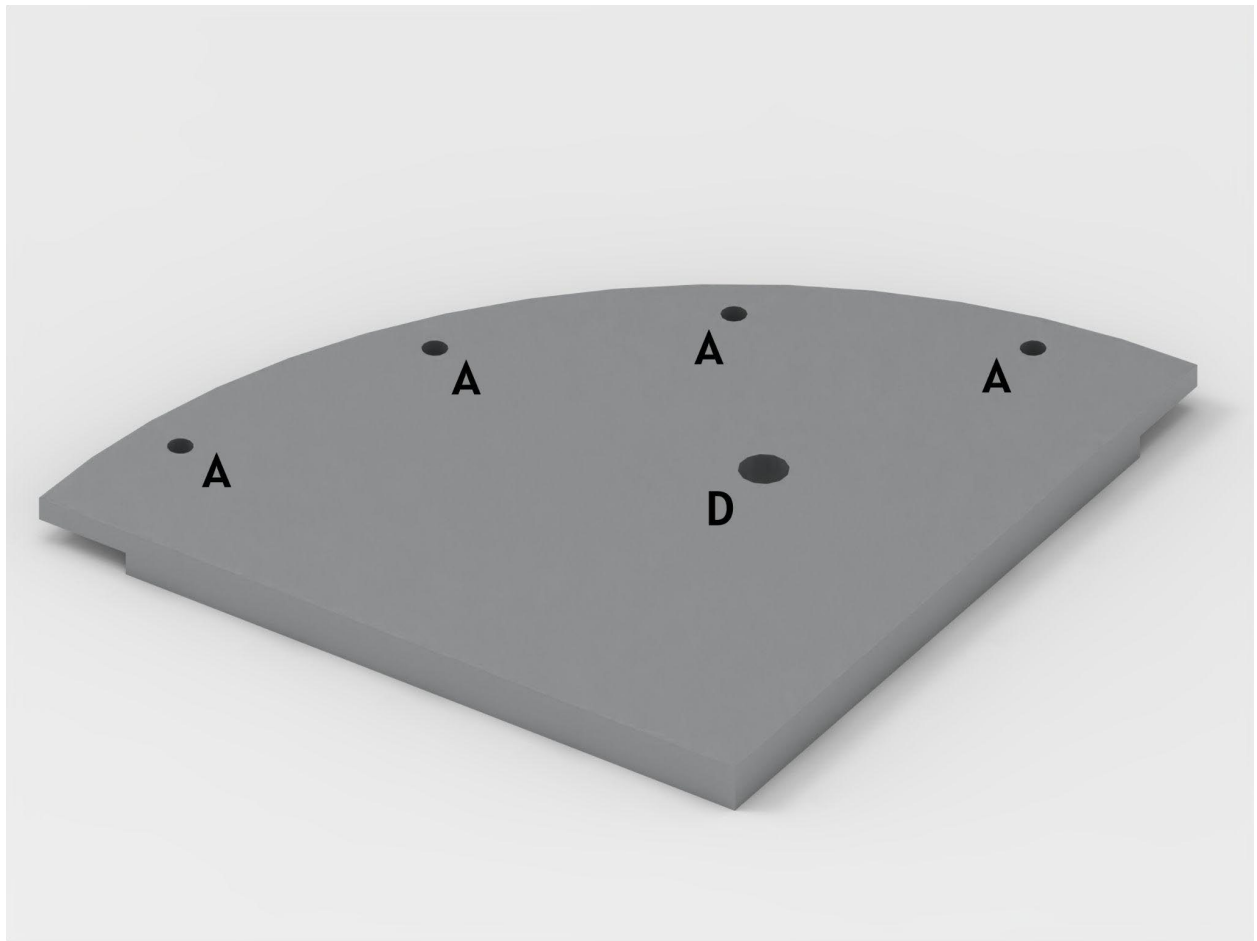


Figure #4 – Crater Base Part V2 (2 required)

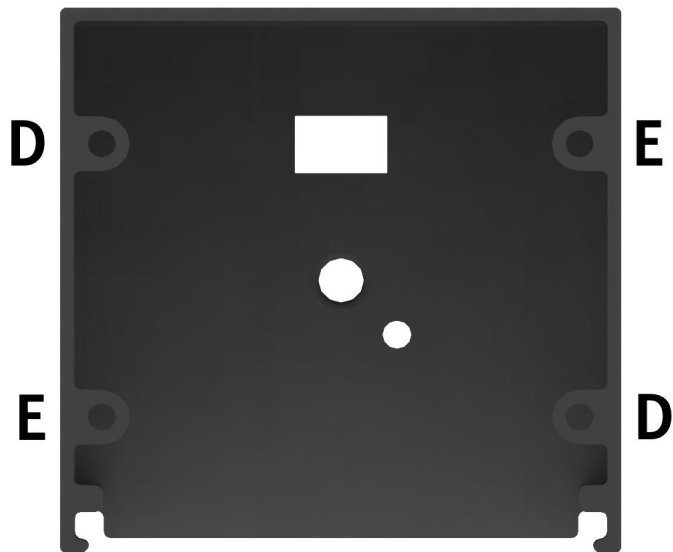


Figure #5 – Bottom View of Crater Antenna Pressure Pad Box



Figure #6 – Crater Assembly Animation

Antenna's

Each of the 4 Antennas are split into 5 main components: the sliding hatch, lower antenna shaft, upper antenna shaft, antenna dish, and the antenna box. Each antenna differs only in the design of the antenna box. Hence, the assembly of each antenna is the same with additional instructions for the antenna boxes. To assemble the antenna refer to the "General Antenna Assembly" section of this document. Then follow the instructions for the specific antenna box used in the assembly of that antenna. The quantity and name of each part required are listed in *Table 2*. The only Antenna requiring extra assembly is the Crank Antenna. Therefore, only the General Antenna Assembly and the Crank Antenna Assembly will be covered in this document.

General Antenna Assembly

No hardware is required to complete the General Antenna Assembly. All parts are held on by friction and are pressed to fit into place. Exercise caution when assembling the antenna parts as too much force will break the mounting points. Use your own judgment to determine if a cylinder is too tight to fit into place. If you determine that it is too tight use sandpaper on the cylindrical insertion points to achieve a looser fit. To assemble the general antenna structure attach the parts as shown in the assembly animation in *Figure #19*.

Crank Antenna Assembly

Part *Crank Housing*, 2 of part *Crank Spacer*, part *Rotary Encoder Sleeve*, and the Rotary Encoder (detailed in the *Antenna Construction Document*) will be required for completion of the following instructions.

1. Begin by placing 2 corresponding nuts for *Screw #2* inside the hexagonal holes, marked "A", of part *Crank Housing*.
2. While holding the nuts from #1 in place, set 2 of part *Crank Spacer* onto part *Crank Housing* as shown in the assembly video marked *Figure #20*.
3. Insert the rotary shaft marked "F" in *Figure #18* into the corresponding crank housing hole marked "F" in *Figure #15*. Ensure that the holes marked "A" in *Figure #18* align with the holes marked "A" in *Figure #15, 16*.
4. Insert *Screw #2* through the hole marked "A" in *Figure #15, 16, 18*. Ensure the the head of *Screw #2* is flush against the PCB of the *Rotary Encoder*. Tighten the screw.
5. Once the *Rotary Encoder* is firmly attached to the *Crank Housing*, matching holes "B", "C", "D", and "E" in *Figure #12* to the corresponding

holes in *Figure #15*. Ensure that the *Rotary Encoder* is located on the inside of the antenna box.

6. Insert 1 of *Screw #1* through each of holes “B”, “C”, “D”, and “E” and fasten.
7. Now, firmly push the *Rotary Encoder Sleeve* onto shaft “F” in *Figure #18*. Note, the sleeve is a very tight fit and will require a lot of force to push onto the *Rotary Encoder*.

Table 2		
Part Name	Quantity	Example Figure
Dish	4	<i>Figure #7</i>
Upper Shaft	4	<i>Figure #8</i>
Lower Shaft	4	<i>Figure #9</i>
Hatch	4	<i>Figure #10</i>
Antenna Box Pressure	1	<i>Figure #11</i>
Antenna Box Crank	1	<i>Figure #12</i>
AB Button	1	<i>Figure #13</i>
AB Keypad	1	<i>Figure #14</i>
Crank Housing	1	<i>Figure #15</i>
Crank Spacer	2	<i>Figure #16</i>
Rotary Encoder Sleeve	1	<i>Figure #17</i>
Rotary Encoder	1	<i>Figure #18</i>

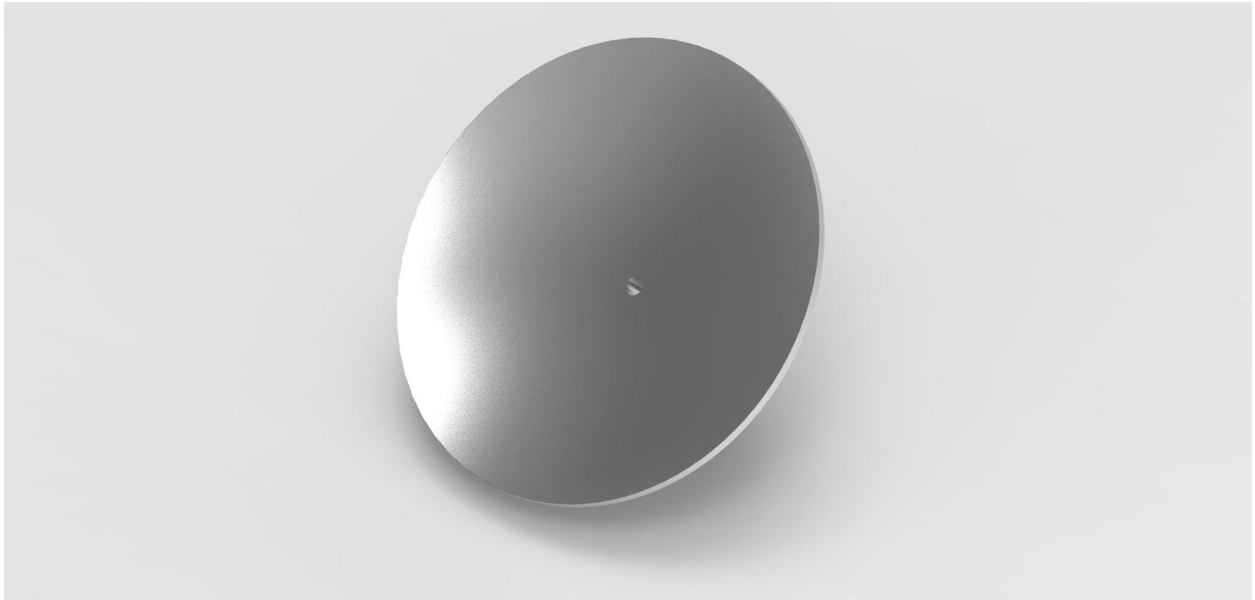


Figure #7 Antenna Dish



Figure #8 Antenna Upper Shaft



Figure #9 Antenna Lower Shaft

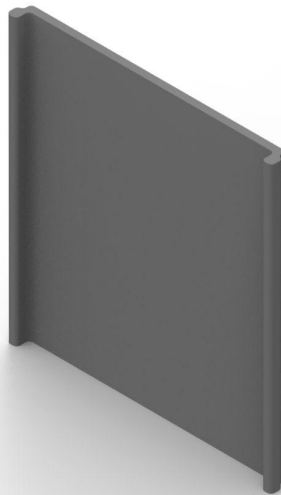


Figure #10 – Antenna Box Hatch

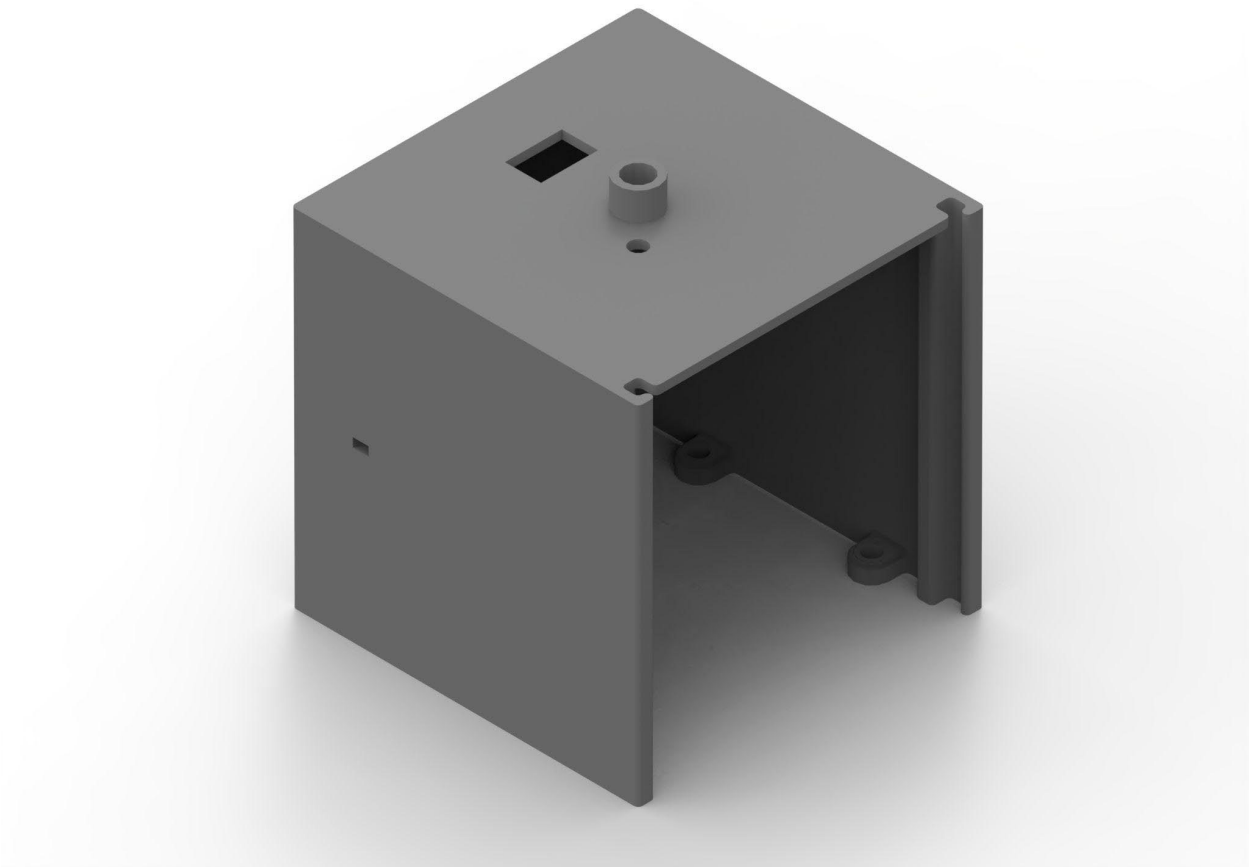


Figure #11 – Antenna Pressure Box

Figure #12

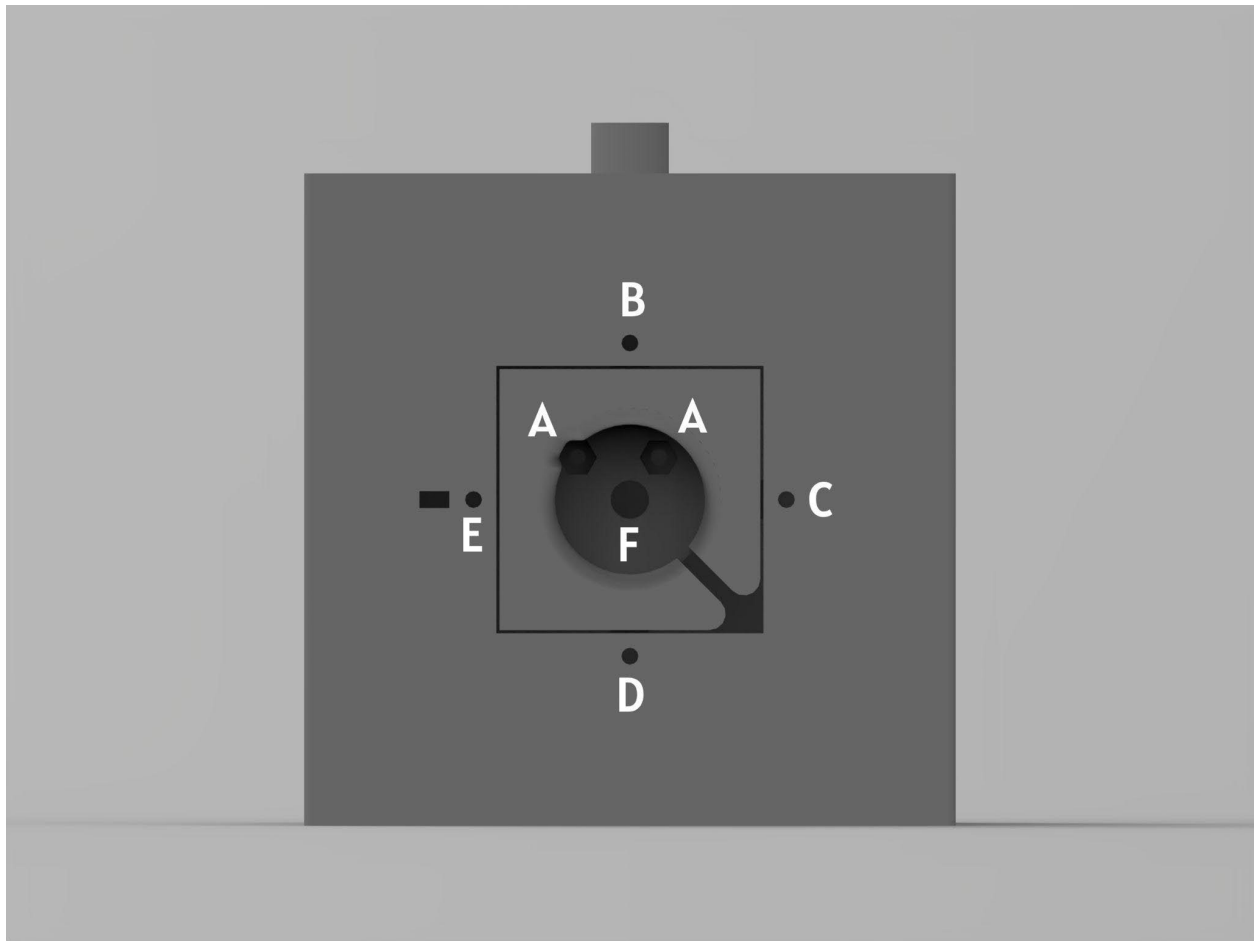


Figure #13

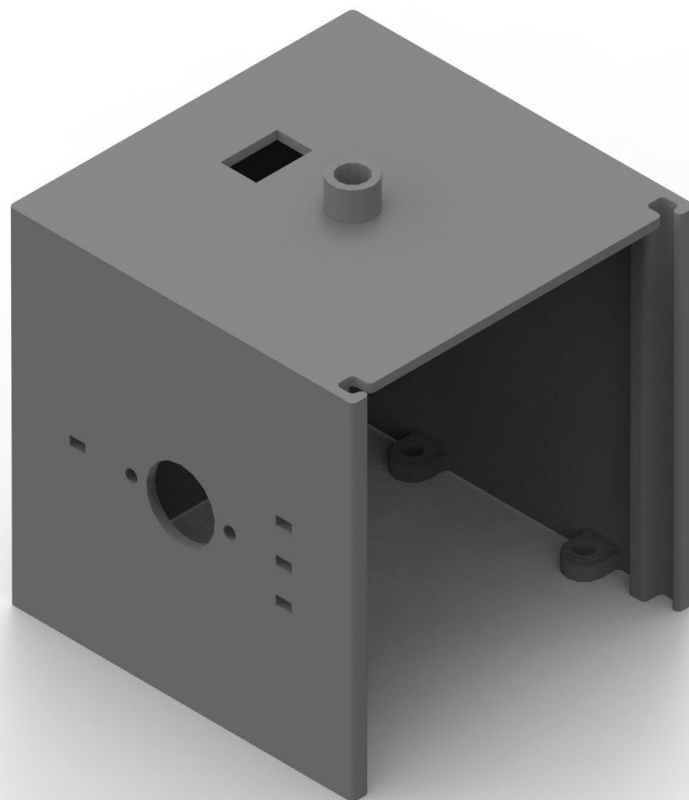


Figure #14

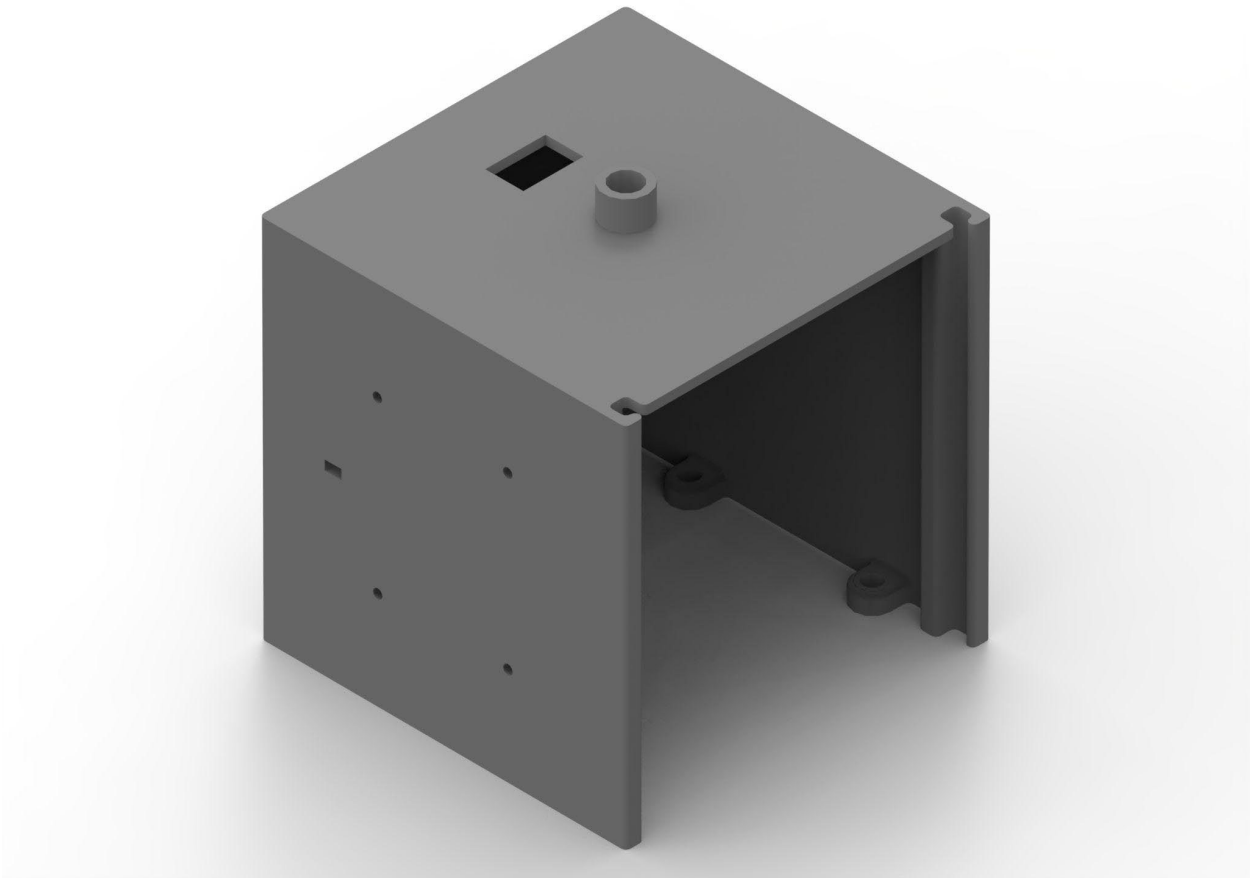


Figure #15

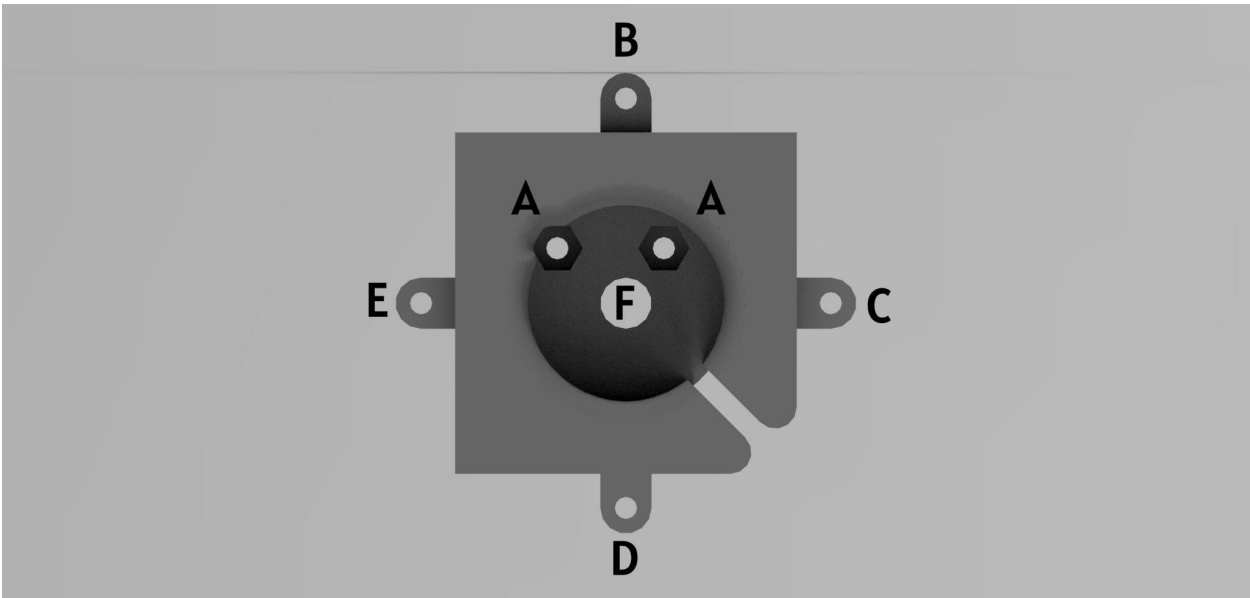


Figure #16

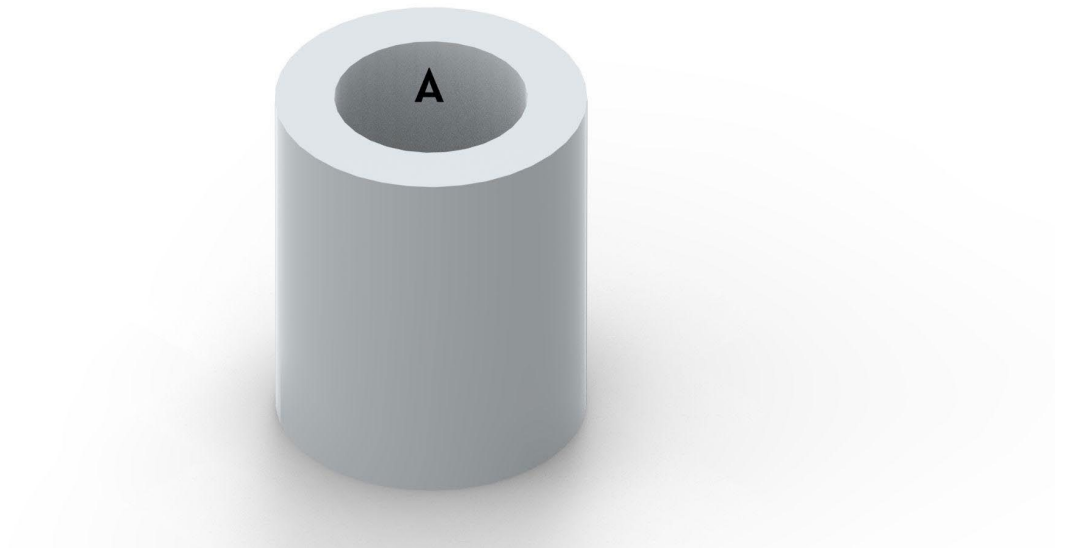


Figure #17

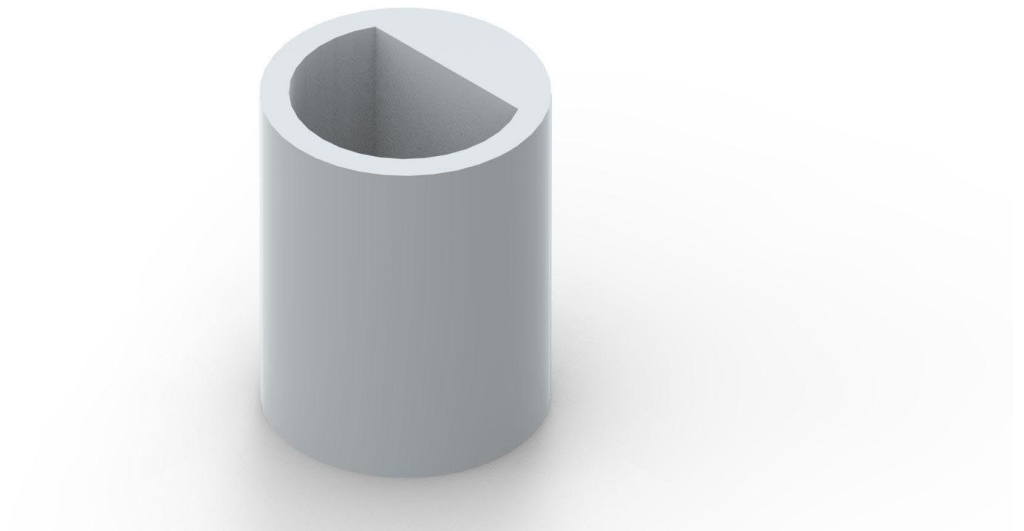


Figure #18

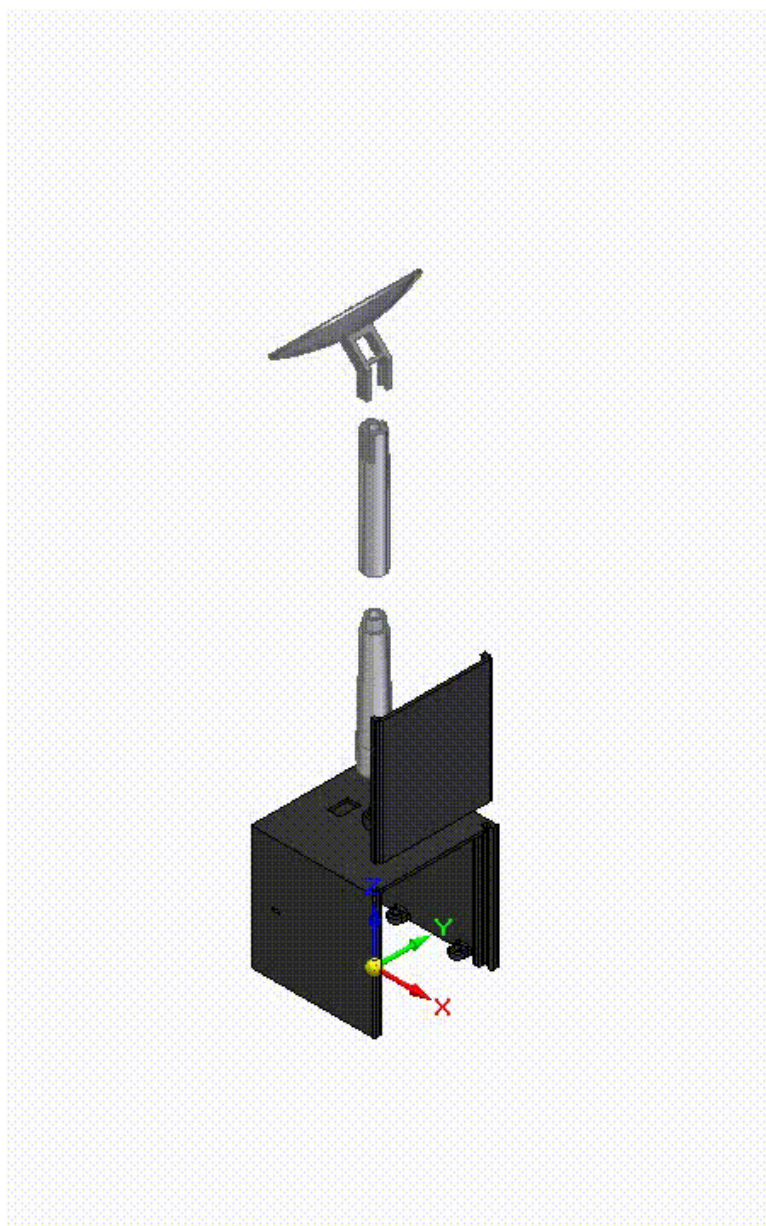
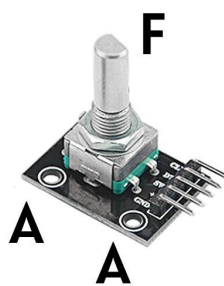
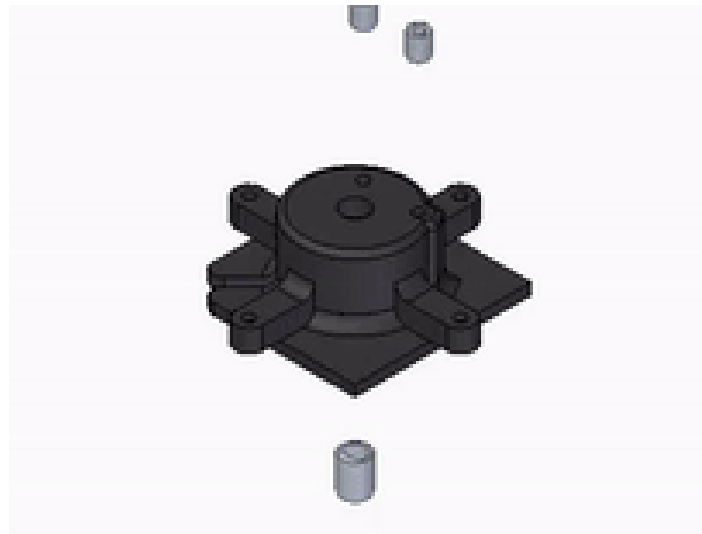


Figure #19

Figure #20



Earth

Earth consists of 3 individual 3D-Printed components: *Shell V1*, *Shell V2*, *Hook*. Each of which are detailed in *Table 3*. Additionally, the *LCD* mentioned in Earth Documents. Full assembly of Earth are detailed in the following instructions:

1. Begin by matching holes “A”, “B”, “C”, and “D” in *Figure #22a,24*. Ensure that the *LCD* is upright with the top facing hole “E” and the *LCD* screen is facing away from Earth.
2. Insert 4 of *Screw #3* through each of holes “A”, “B”, “C”, and “D” and fasten.
3. Next, insert a piece of twine, wire, string, or whatever material will be used to suspend Earth and insert it through hole “G” shown *Figure #23* of part *Hook*. Once inserted, tie a knot large enough that it cannot pass through hole “G”.
4. Now, match hole “H” and “I” in *Figure #21b,22b*. Ensure that *Hook* is within Earth and the material used to tie the knot passes through hole “F” in *Figure #22a*. Next, insert 1 of *Screw #1* through both hole “H” and “I” and fasten.

Table 3

Part Name	Quantity	Example Figure
Shell V1 (Front) Shell V1 (Back)	1	<i>Figure #21a</i> <i>Figure #21b</i>
Shell V2 (Front) Shell V2 (Back)	1	<i>Figure #22a</i> <i>Figure #22b</i>
Hook	1	<i>Figure #23</i>
LCD	1	<i>Figure #24</i>

Figure #21a

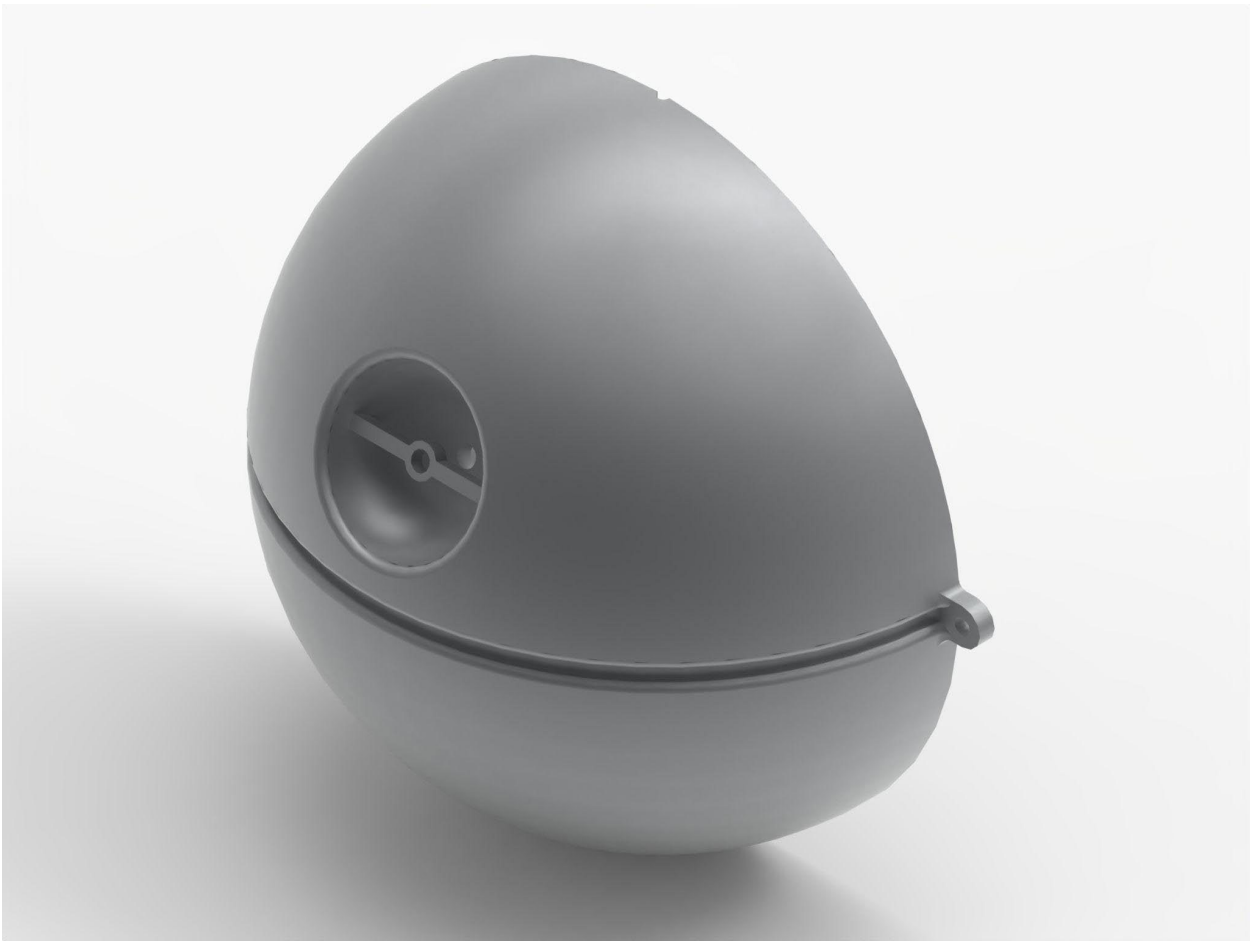


Figure #21b

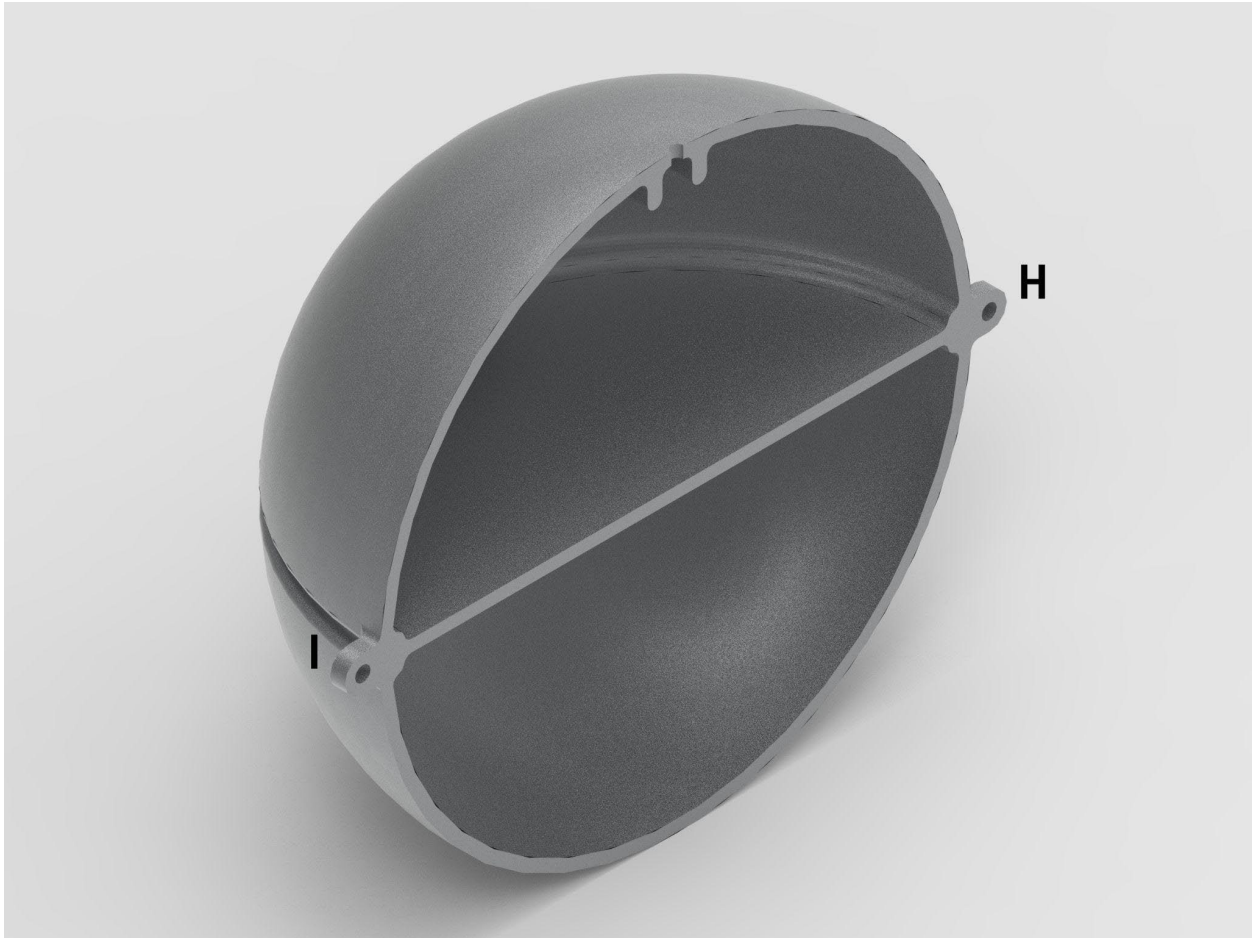


Figure #22a

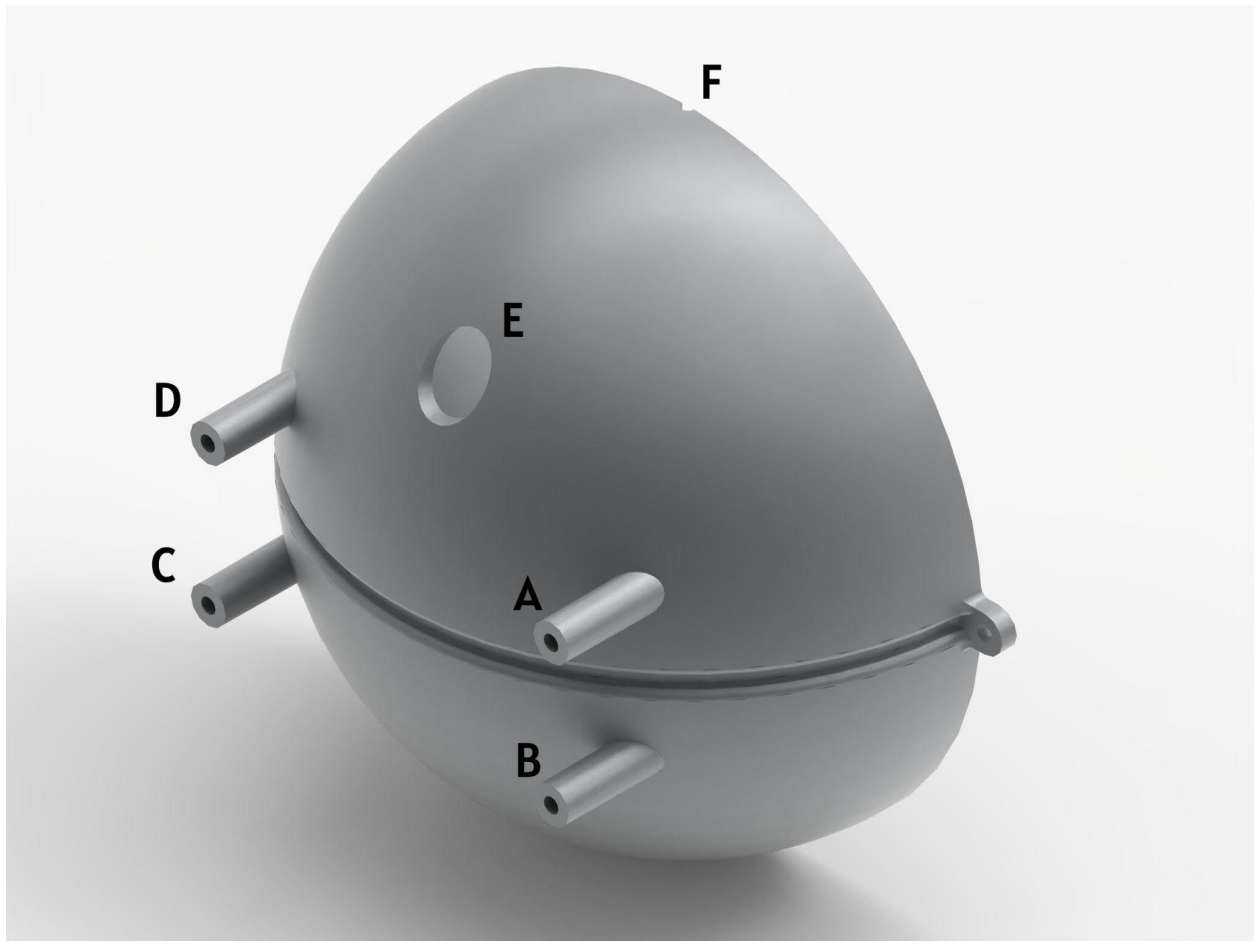


Figure #22b



Figure #23

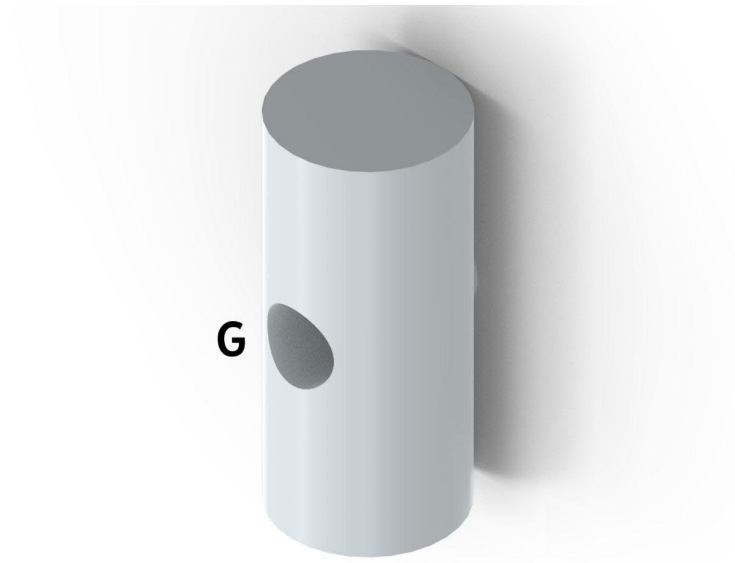
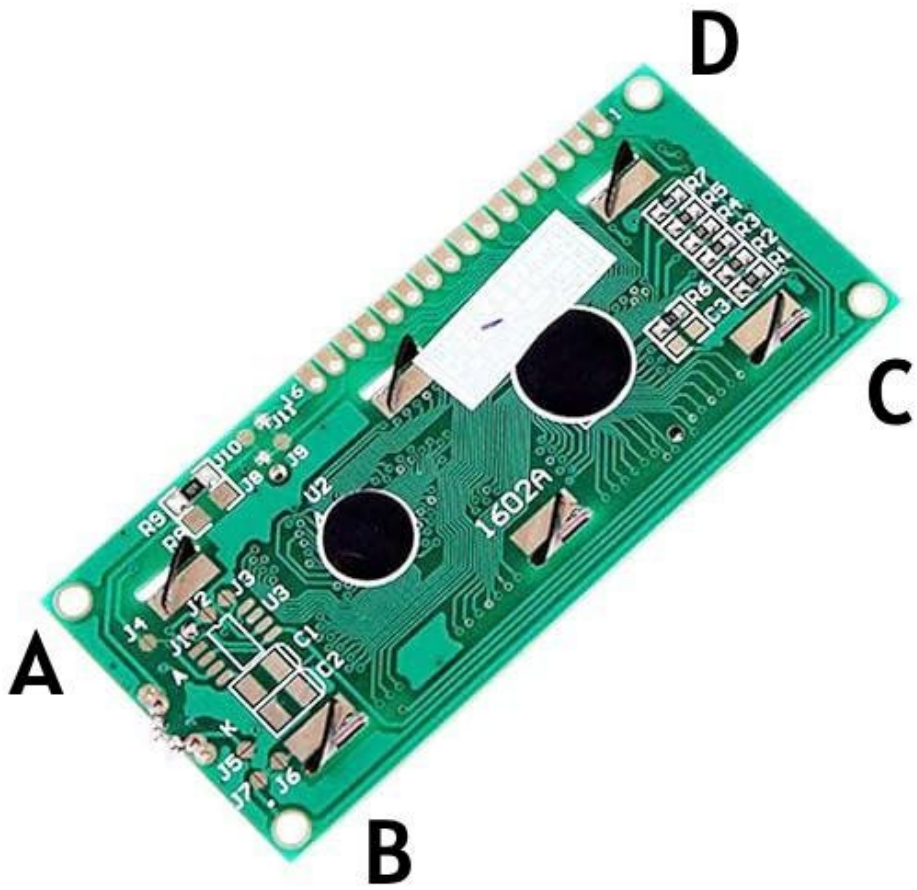


Figure #24



Screw Table		
Screw Type (Type-Length)	Quantity	Referred To By
2-56 - ¾"	42	<i>Screw #1</i>
2-56 - ½"	2	<i>Screw #2</i>
4-40 - 1¼"	4	<i>Screw #3</i>
8-32 - 1"	16	<i>Screw #4</i>