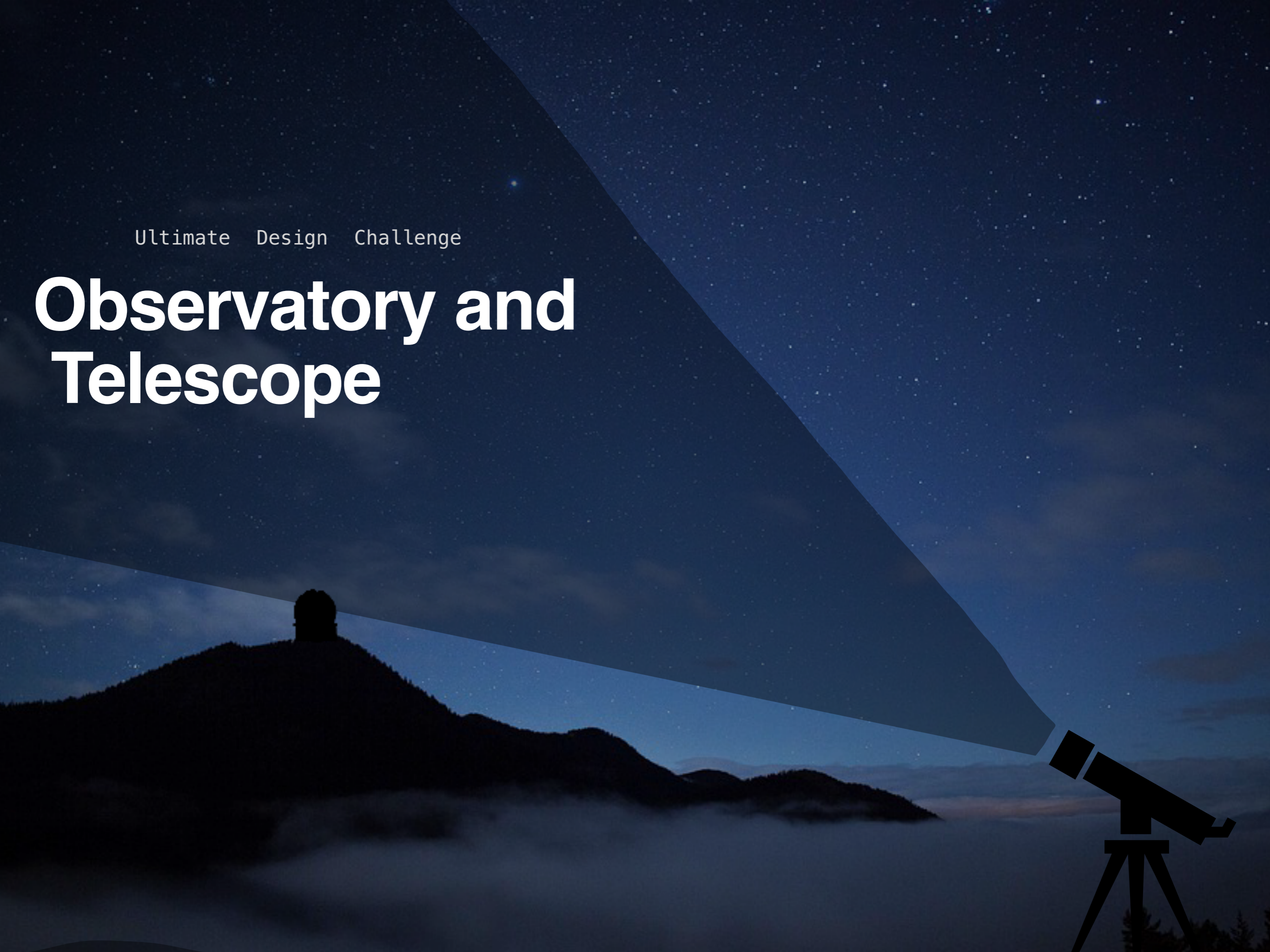
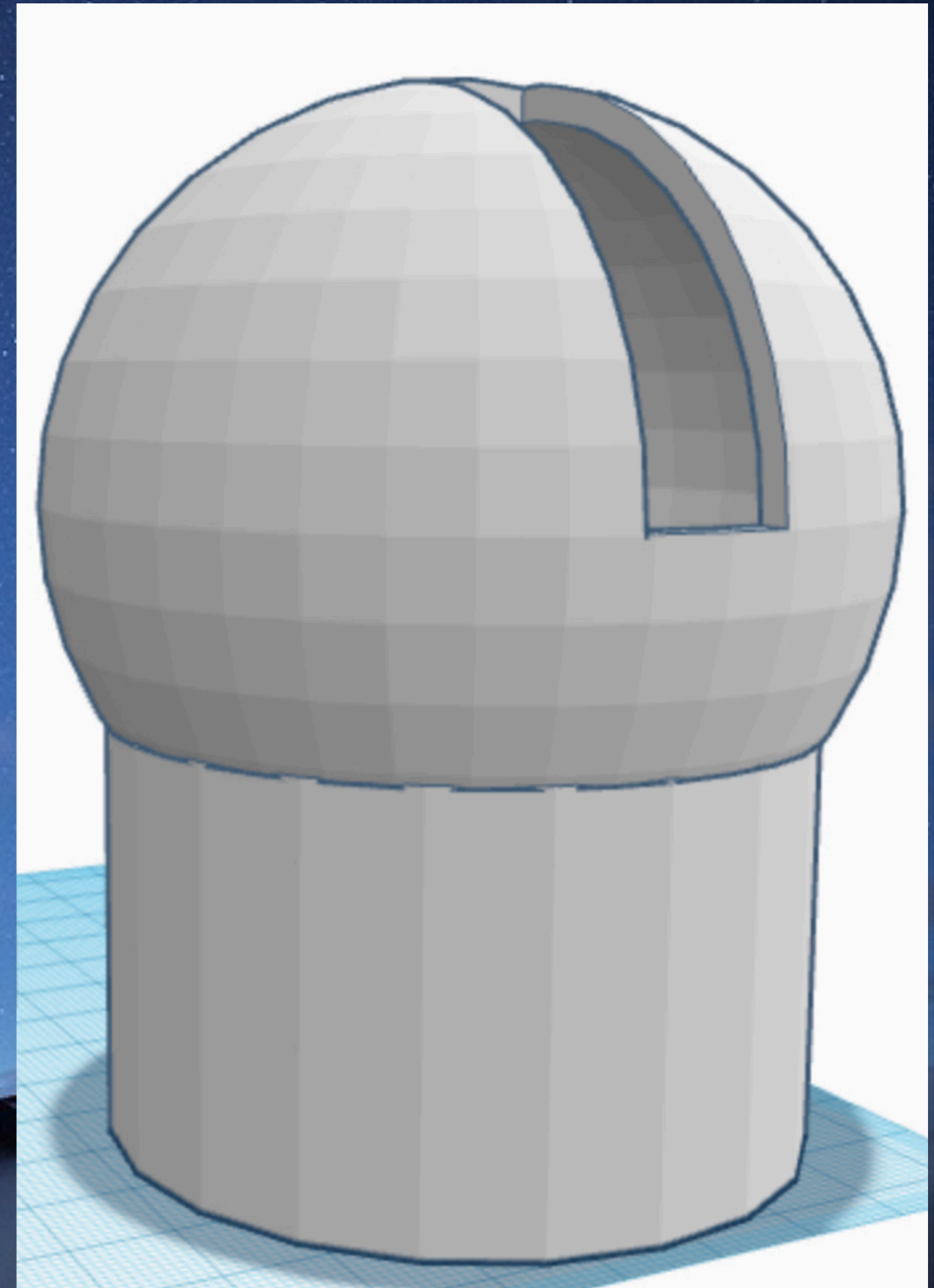
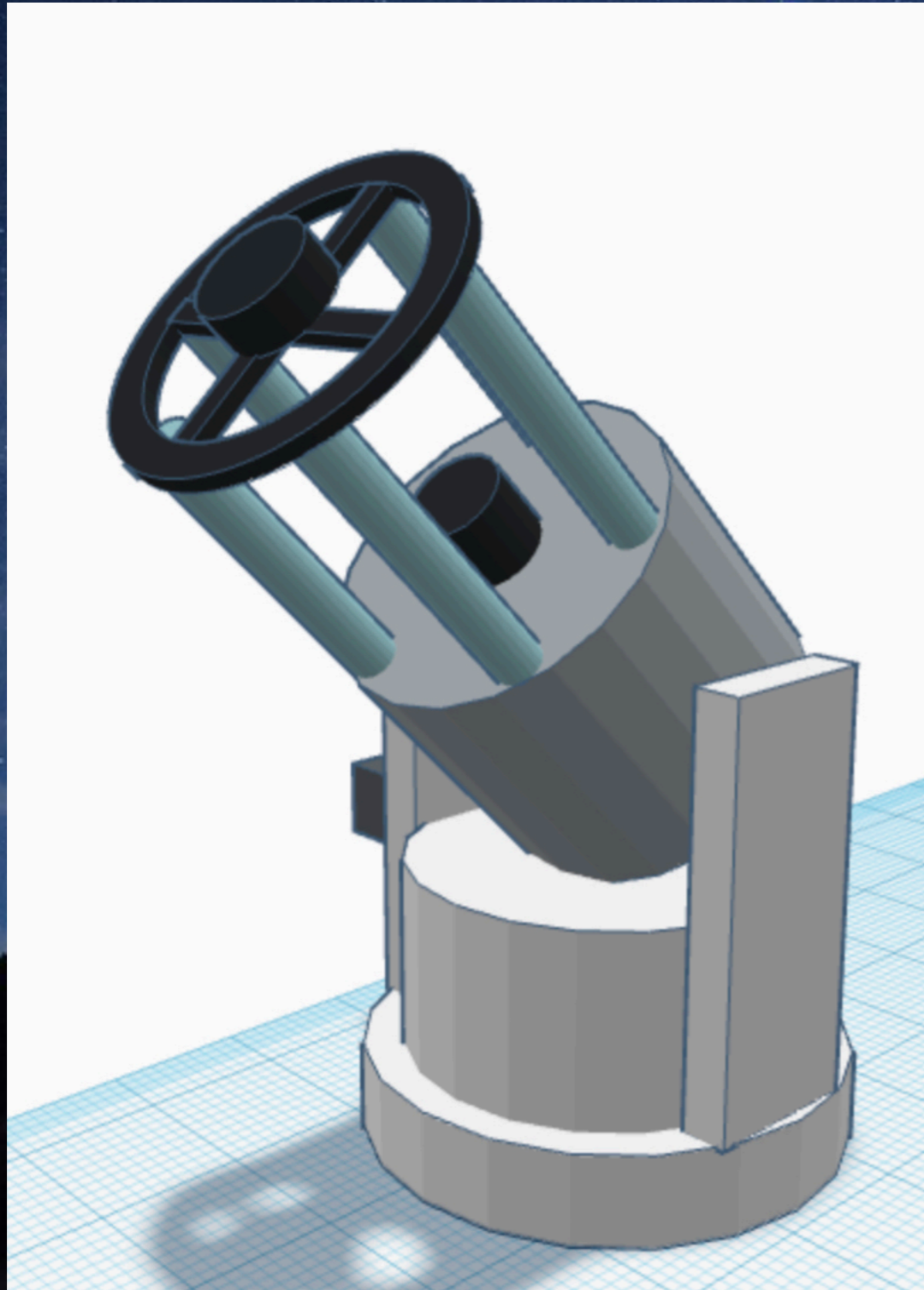


Ultimate Design Challenge

# Observatory and Telescope

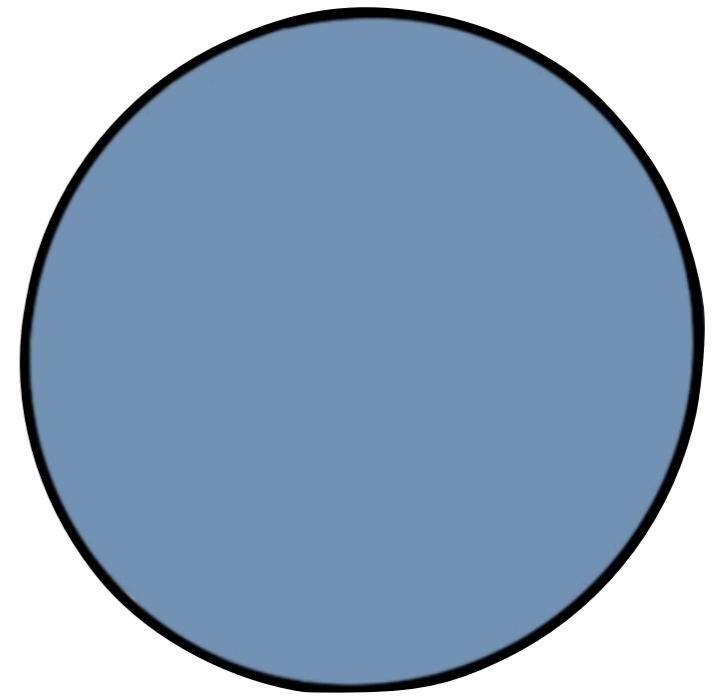
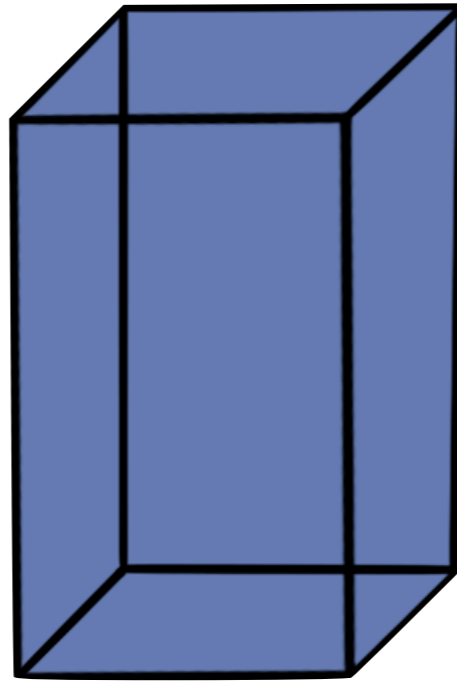
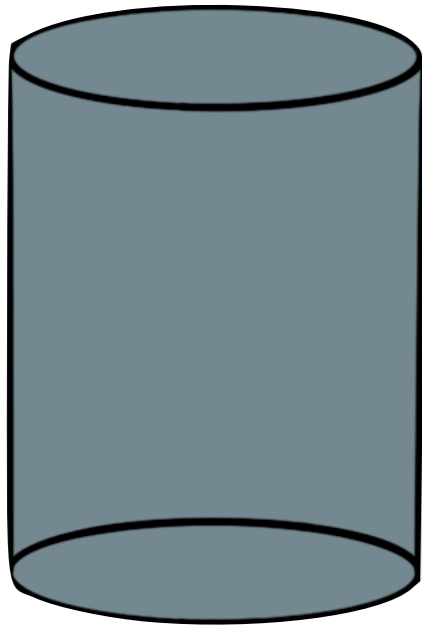


# Maximized For Volume<sup>3</sup>



# Shapes

yay!

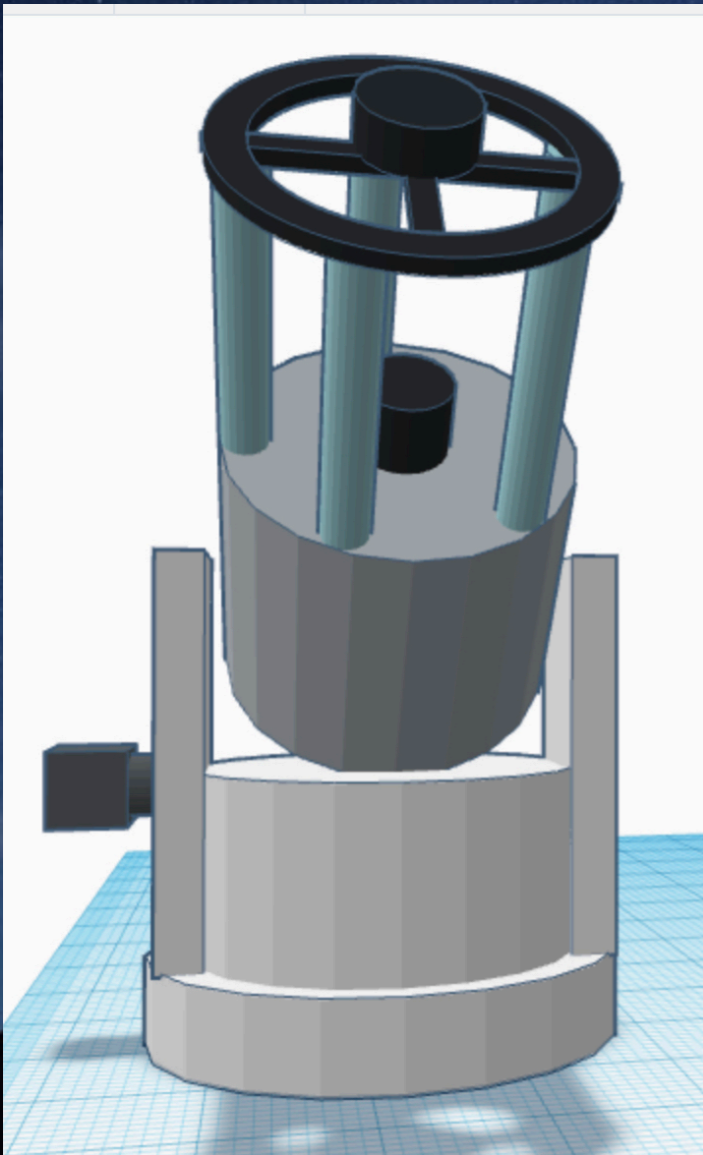


- Cylinder -  
 $V = \pi r^2 h$   
 $SA = 2\pi r^2 + 2\pi r h$

- Rectangular Prism -  
 $V = l \times w \times h$   
 $SA = 2(l \times w) + 2(l \times h) + 2(h \times w)$

- Sphere -  
 $V = \frac{4}{3}\pi r^3 \times 0.75$   
 $SA = 4\pi r^2 \times 0.75$

# Surface Area & Volume Telescope



Total SA =  $8,569.04 \text{ mm}^2$

Total V =  $22,540.78 \text{ mm}^3$

**cylinder 5**  
 $d = 3 \text{ mm}$   
 $h = 30 \text{ mm}$   
 \* Both circle are not showing  
 $SA = 2\pi r^2 + 2\pi rh$   
 $= 2(\pi(1.5)^2) + 2(\pi(1.5)(30))$   
 $= 2(7.0686) + 2(141.37)$   
 $= 14.1372 + 282.74$   
 $= 296.8772$   
 $V = \pi r^2 h$   
 $= (\pi(1.5)^2)(30)$   
 $= 110.775$   
 Total SA =  $92.4 \text{ mm}^2$  (Note: handwritten calculation shows 296.8772)

**cylinder 6**  
 $d = 6 \text{ mm}$   
 $h = 5 \text{ mm}$   
 \* 1 circle face is not showing  
 $SA = 2\pi r^2 + 2\pi rh$   
 $= 2(\pi(3)^2) + 2(\pi(3)(5))$   
 $= 2(28.2743) + 2(47.1239)$   
 $= 56.5486 + 94.2478$   
 $= 150.7964$   
 $V = \pi r^2 h$   
 $= (\pi(3)^2)(5)$   
 $= 141.3717$

**cylinder 7**  
 $d = 23 \text{ mm}$   
 $h = 80 \text{ mm}$   
 $SA = 2\pi r^2 + 2\pi rh$   
 $= 2(\pi(11.5)^2) + 2(\pi(11.5)(80))$   
 $= 2(415.91) + 2(2916.8)$   
 $= 831.82 + 5833.6$   
 $= 6665.42$   
 $V = \pi r^2 h$   
 $= (\pi(11.5)^2)(80)$   
 $= 3309.61$   
 Math for collision:  
 $2,276.06 \text{ mm}^2$   
 $- 7.06 \times 5$   
 $- 28.27$   
 $= 2,270.73 \text{ mm}^2$

**cylinder 8**  
 $d = 27$   
 $h = 13$   
 \* one circle face showing  
 $SA = 2\pi r^2 + 2\pi rh$   
 $= 2(\pi(13.5)^2) + 2(\pi(13.5)(13))$   
 $= 2(572.55) + 2(551.34)$   
 $= 1145.1 + 1102.68$   
 $= 2247.78$   
 $V = \pi r^2 h$   
 $= (\pi(13.5)^2)(13)$   
 $= 7,443.21 \text{ mm}^3$

**cylinder 9**  
 $d = 33 \text{ mm}$   
 $h = 6 \text{ mm}$   
 $SA = 2\pi r^2 + 2\pi rh$   
 $= 2(\pi(16.5)^2) + 2(\pi(16.5)(6))$   
 $= 2(855.99) + 2(311.01)$   
 $= 1,711.98 + 622.02$   
 $= 2,334.00$   
 $V = \pi r^2 h$   
 $= (\pi(16.5)^2)(6)$   
 $= 5,131.79 \text{ mm}^3$   
 Math for collision:  
 $2,332.60$   
 $- 572.55$   
 $- 33$   
 $- 33$   
 $= 1,694.05 \text{ mm}^2$

**cylinder 10**  
 $d = 7 \text{ mm}$   
 $h = 3 \text{ mm}$   
 $SA = 2(\pi(3.5)^2) + 2(\pi(3.5)(3))$   
 $= 2(38.48) + 2(65.96)$   
 $= 76.96 + 131.92$   
 $= 208.88$   
 $V = (\pi(3.5)^2)(3)$   
 $= 115.45 \text{ mm}^3$   
 Math 4 collision:  
 $142.92 \text{ mm}^2$   
 $- 7 \times 1.5 \times 2$   
 $= 142.92 - 21 = 121.92 \text{ mm}^2$

**cylinder 11**  
 $d = 4 \text{ mm}$   
 $h = 2 \text{ mm}$   
 $SA = 2(\pi(2)^2) + 2(\pi(2)(2))$   
 $= 2(12.56) + 2(25.12)$   
 $= 25.12 + 50.24$   
 $= 75.36$   
 $V = (\pi(2)^2)(2)$   
 $= 25.13 \text{ mm}^3$   
 Math 4 collision:  
 $12.56 + 25.12 = 37.68 \text{ mm}^2$

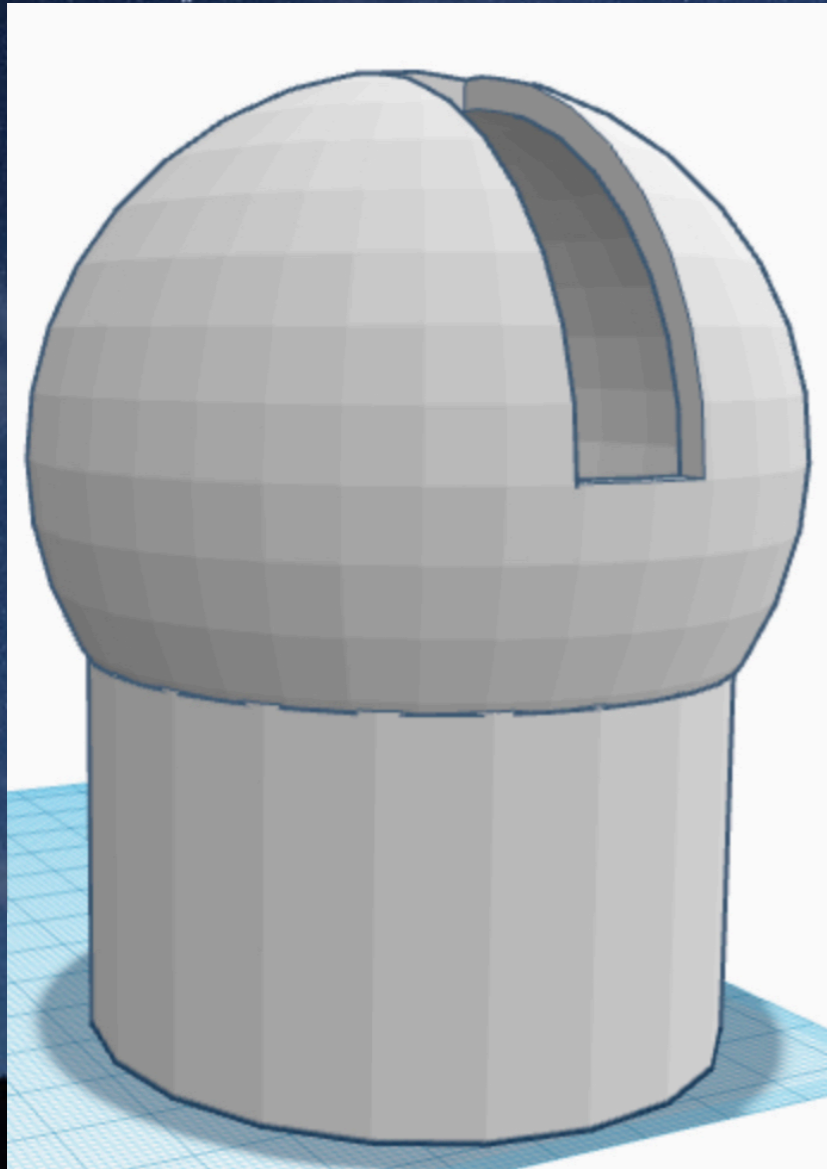
**cylinder 12**  
 $d = 23 \text{ mm}$   
 $h = 19 \text{ mm}$   
 $SA_{OC} = 2(\pi(11.5)^2) + 2(\pi(11.5)(1))$   
 $= 830.95 + 72.25 = 903.2 \text{ mm}^2$   
 $- \text{circles} = -2(\pi(1.5)^2) = -569.05$   
 $+ \text{cylinder wall} = 2(\pi(1.5)(9.5)) = 59.69$   
 $SA = 393.84$   
 $V_{OC} = (\pi(11.5)^2)(1) = 415.47$   
 $V_{IC} = (\pi(1.5)^2)(1) = 283.52$   
 $= 415.47 - 283.52$   
 $\text{total } V = 131.95 \text{ mm}^3$   
 Math 4 collision:  
 $393.84$   
 $- 1.5 \times 1 \times 4$   
 $= 393.84 - 6 = 387.84 \text{ mm}^2$

**RP 13+14**  
 $SA = 2(lxw) + 2(wxh) + 2(lxh)$   
 $= 2(11 \times 28) + 2(28 \times 3) + 2(11 \times 3)$   
 $= 616 + 168 + 66 = 850 \text{ mm}^2$   
 $V = l \times w \times h$   
 $= 11 \times 3 \times 28 = 924 \text{ mm}^3$   
 Math 4 collision:  
 $28 \times 11 = 308$   
 $- 11 \times 13 = 143$   
 $= 308 - 143 = 165$   
 $\text{total } SA = 685 \text{ mm}^2$   
 $\times 2 = 1,370 \text{ mm}^2$

**RP 15-16**  
 $SA = 2(lxw) + 2(wxh) + 2(hx1)$   
 $= 2(1.5 \times 1) + 2(1 \times 18) + 2(18 \times 1.5)$   
 $= 3 + 36 + 54 = 93 \text{ mm}^2$   
 $V = l \times w \times h$   
 $= 1.5 \times 1 \times 18 = 27 \text{ mm}^3$   
 Collision Math:  
 $93 \text{ mm}^2$   
 $- 1.5 \times 1 \times 4$   
 $- 7 \times 1.5 \times 2$   
 $= 93 - 6 - 21 = 66$   
 $\text{total } SA = 132 \text{ mm}^2$

**RP 17**  
 $SA = 2(lxw) + 2(1xh) + 2(wxh)$   
 $= 2(6 \times 5) + 2(6 \times 5) + 2(5 \times 5)$   
 $= 60 + 60 + 50 = 170 \text{ mm}^2$   
 $V = l \times w \times h$   
 $= 6 \times 5 \times 5 = 150 \text{ mm}^3$   
 Math for collision:  
 $170$   
 $- 12.56$   
 $\text{total } SA = 157.44 \text{ mm}^2$

# Surface Area & Volume Observatory



Total SA =  $43,696.62 \text{ mm}^2$

Total V =  $63,650.14 \text{ mm}^3$

**Sphere**

SA =  $4\pi r^2$   
 $= 4(3.14)(41^2)$   
 $= 4(5,281.01)$   
 $= 21,124.04 \text{ mm}^2$

3/4 of this sphere  
 $= 21,124.04 \times 0.75$   
 $= 15,843.03 \text{ mm}^2$

OC =  $\frac{4}{3}\pi r^3$   
 $= 1.33(3.14)(41^3)$   
 $= 1.33(216,521.70)$   
 $= 287,975.861$

3/4 of this sphere  
 $= 287,975.861 \times 0.75$   
 $= 215,980.39 \text{ mm}^3$

**Hole in sphere**

SA =  $2(lxw) + 2(wxh) + 2(lxh)$   
 $= 2(14 \times 6) + 2(6 \times 64.4) + 2(14 \times 64.4)$   
 $= 169.2 + 772.8 + 1816.08 = 2758.08 \text{ mm}^2$

V =  $l \times w \times h$   
 $= 14 \times 6 \times 64.4 = 5448.24 \text{ mm}^3$

**inner sphere**

SA =  $4\pi r^2$   
 $= 4(3.14)(35^2)$   
 $= 15,145.84 \text{ mm}^2$

3/4  
 $= 15,145.84 \times 0.75 = 11,359.38 \text{ mm}^2$

V =  $\frac{4}{3}\pi r^3$   
 $= 1.33(3.14)(35^3)$   
 $= 229,847.29$

3/4  
 $= 229,847.29 \times 0.75 = 172,385.46 \text{ mm}^3$

**base**

SA = \* only inner and outer cylinder walls showing

OC =  $2\pi r h$   
 $= 2(3.14)(34.5)(41)$   
 $= 8,887.56$

add IC =  $2(3.14)(31.5)(41)$   
 $= 8,114.73$

SA =  $8,887.56 + 8,114.73 = 17,002.29 \text{ mm}^2$

OC V =  $(3.14)(34.5^2)(41) = 153,310.51$

IC V =  $(3.14)(31.5^2)(41) = 127,807.05$

remaining:  $25,503.45 \text{ mm}^3$

**Total SA of sphere**

OS 15,843.03  
 subtract 2758.08  
 add 13,609.38  
 SA = 26,694.33 mm<sup>2</sup>

**Total V of sphere**

total OC: 215,980.39 mm<sup>3</sup>  
 total IC: 172,385.46 mm<sup>3</sup>  
 total hole: 5,448.24 mm<sup>3</sup>  
 remaining: 38,146.69 mm<sup>3</sup>

**base**

69mm  
 63mm  
 h = 41mm

SA = \* only inner and outer cylinder walls showing

OC =  $2\pi r h$   
 $= 2(3.14)(34.5)(41)$   
 $= 8,887.56$

add IC =  $2(3.14)(31.5)(41)$   
 $= 8,114.73$

SA =  $8,887.56 + 8,114.73 = 17,002.29 \text{ mm}^2$

OC V =  $(3.14)(34.5^2)(41) = 153,310.51$

IC V =  $(3.14)(31.5^2)(41) = 127,807.05$

remaining:  $25,503.45 \text{ mm}^3$

# Ratios

## Volume:Surface Area

### Observatory Telescope Ratio

Ratio V:SA

V:SA

$$\begin{array}{r} SA = 26,694.33 \\ + 17,002.29 \\ \hline 43,696.62 \text{ mm}^2 \end{array}$$

$$\begin{array}{r} V = 38,146.69 \\ + 25,503.45 \\ \hline 63,650.14 \text{ mm}^3 \end{array}$$

Ratio V:SA

$$\begin{aligned} 63,650.14 : 43,696.62 \\ = \frac{63,650.14}{43,696.62} &= \rightarrow \\ &1.45:1 \\ &\downarrow \downarrow \\ &1.45 \text{ mm}^3 : 1 \text{ mm}^2 \end{aligned}$$

$$\begin{array}{r} SA = 92.40 \\ 687.99 \\ 2212.49 \\ 1675.23 \\ 1694.05 \\ 121.92 \\ 37.68 \\ 387.84 \\ 1370.00 \\ 132.00 \\ + 157.44 \\ \hline 8,569.04 \text{ mm}^2 \end{array}$$

$$\begin{array}{r} V = 141.37 \\ 141.37 \\ 8309.51 \\ 7443.21 \\ 5131.79 \\ 115.45 \\ 25.13 \\ 131.95 \\ 924.00 \\ 27.00 \\ + 150.00 \\ \hline 22,540.78 \text{ mm}^3 \end{array}$$

Ratio V:SA

$$\begin{aligned} 22,540.78 \text{ mm}^3 : 8,569.04 \text{ mm}^2 \\ = \frac{22,540.78}{8,569.04} &= \rightarrow \\ &2.63:1 \\ &\downarrow \downarrow \\ &2.63 \text{ mm}^3 : 1 \text{ mm}^2 \end{aligned}$$

Total Ratio V:SA

$$\begin{array}{r} V = 63,650.14 \\ + 22,540.78 \\ \hline 86,190.92 \text{ mm}^3 \\ SA = 43,696.62 \\ + 8,569.04 \\ \hline 52,265.66 \text{ mm}^2 \end{array} \quad \begin{array}{l} 86,190.92 \text{ mm}^3 : 52,265.66 \\ = \frac{86,190.92}{52,265.66} = \rightarrow 1.64:1 = 1.64 \text{ mm}^3 : 1 \text{ mm}^2 \end{array}$$

A night sky filled with stars, with a dark silhouette of a mountain range in the foreground. The sky is a deep blue, and the stars are scattered across it. The mountain range is dark and silhouetted against the lighter sky. The word "Thanks!" is written in large, white, bold letters across the center of the image.

**Thanks!**