Question 2

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Calculating the dimensions of a PokeBall

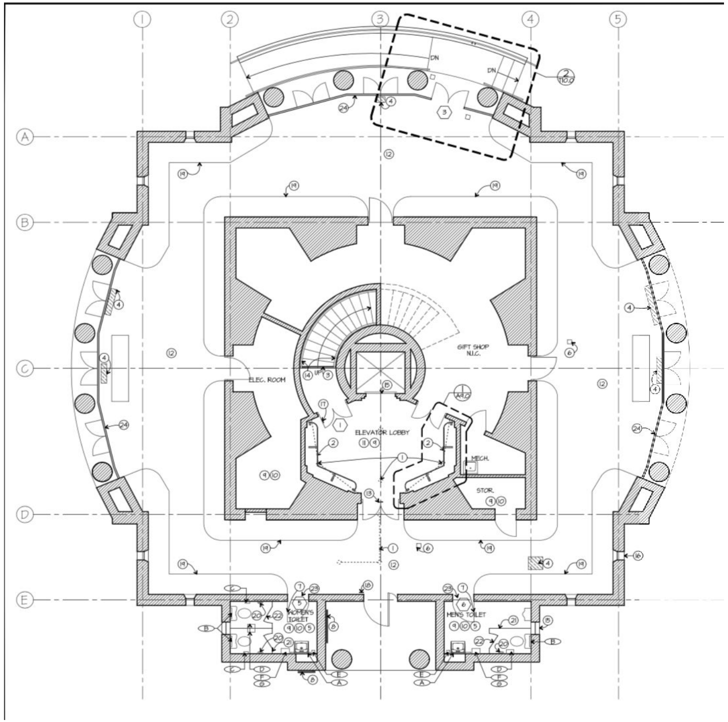
- Since there is no official documentation regarding the dimensions of a pokeball, I will be using the measurements of a Baseball as a substitute for a pokeball considering they are of similar proportions
- According to the "2014 Official Baseball Rules", a Baseball has a Diameter of approximately 2(⅞)-3 inches.
- The formula for the volume of a sphere is: $V = (3/4)(\pi)(r^3)$
- This gives us a volume of $13.39in^3$ or $0.0077430556ft^3$

Calculating free space in Coit Tower

- In order to calculate the available volume of coit tower, we need to calculate volume of each floor in the tower
- To do this I will be referencing an architectural drawing of coit memorial tower from the The Architectural Resources Group - ‘http://mission.sfgov.org/oca_bid_attachments/FA30915.pdf’
- According to the document there are 13 levels in coit memorial tower, however, anything above the 10th floor will be excluded as well as the outer area of the 2nd floor. This is because there are no walls, therefore we wouldn't be able to hold pokeballs.

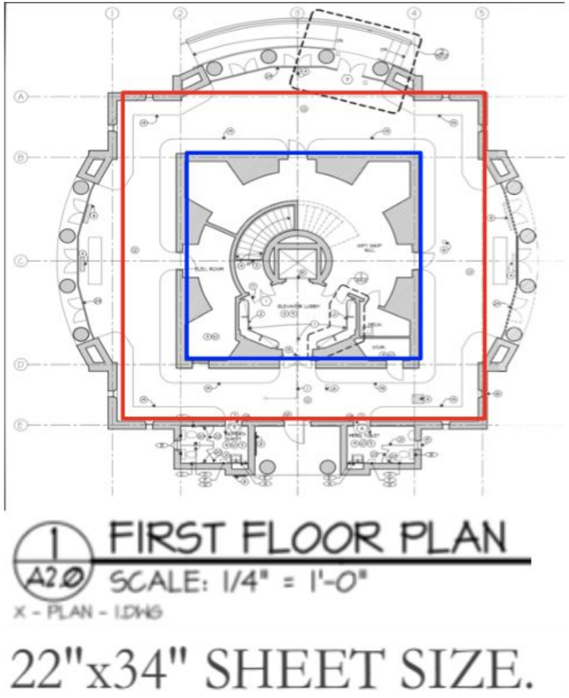
Calculating 1st floor volume...

- Due to the shape complexities of the floor layout, I will approach this problem by breaking things down into smaller pieces and sum the volume of those pieces to get an estimate of our desired result.



Calculating 1st floor volume...(continued)

- The first thing I noticed from this drawing is that the overall shape resembles a square(blue) within a square(red).
- So I will first calculate the volume of the outer area of the 1st floor by subtracting the volume of the blue rectangular prism(inner area) from the red rectangular prism(outer area)
- I'd like to note that according to the drawing, ¼" = 1'. Therefore I will scale the drawing accordingly so that my measurements remain accurate.

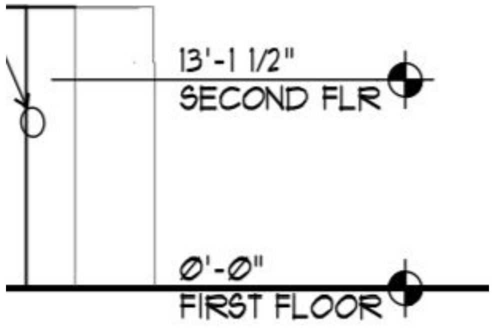


Calculating 1st floor volume...(Outer area volume)

- The Red Square
  - Length: 14.25 in. or 57ft
  - Width: 13.5 in or 54ft

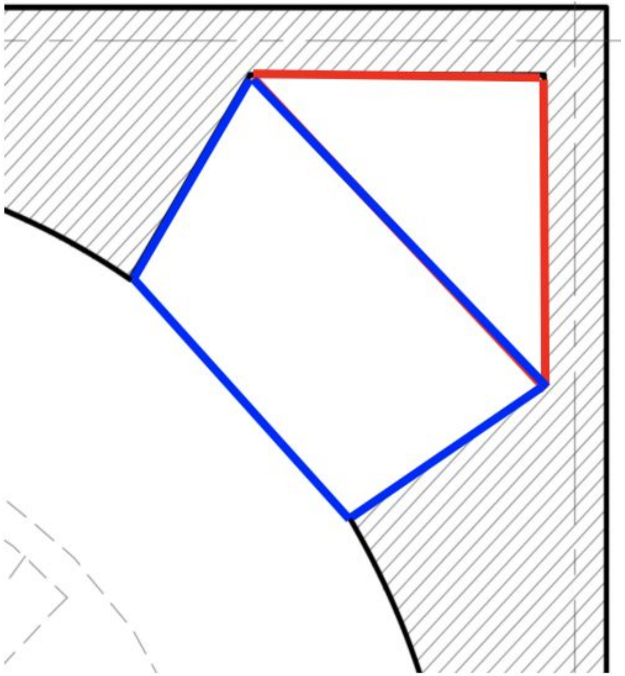
- The Blue Square
  - Length: 9.25 in. or 37ft
  - Width: 8.5 in. or 34ft

- The diagram states that the height from the 1st floor to the 2nd is 13.125ft or 157.5 inches.
- Using the formula to calculate the volume of a rectangular prism we get:
  - Red Rectangular Prism Volume = (57ft)(54ft)(13.125ft) = 40,398.75ft^3
  - Blue Rectangular Prism Volume = (37ft)(34ft)(13.125ft) = 16,511.25 ft^3
  - ***Outer area volume = 40,398.75 ft^3 - 16,511.75 ft^3 = 23,887.5 ft^3***



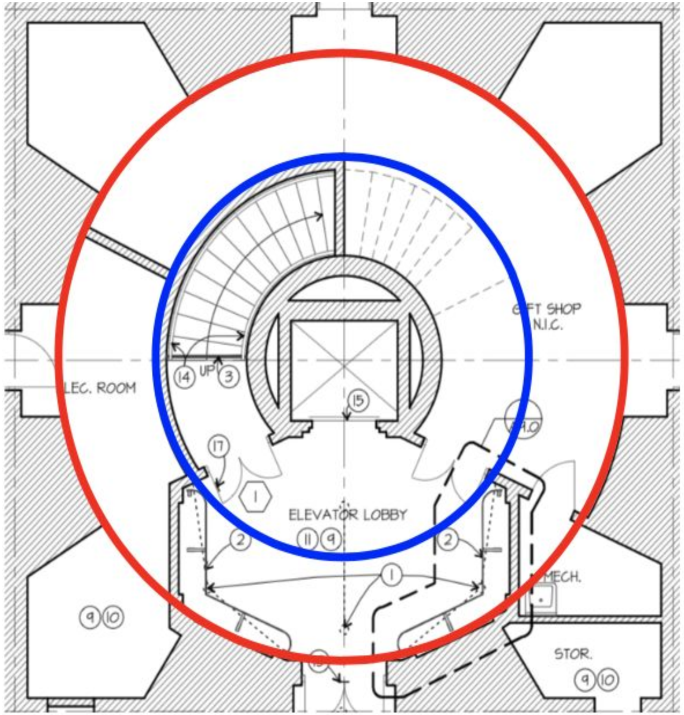
Calculating 1st floor volume...(Inner area volume)

- For the Inner area, I noticed that the corners resembled a pentagon, however since the sides of the pentagon are not all equal I will have to use a different approach.
- Instead I have chosen to break this down into two shapes: a **triangle** and a **trapezoid**
- Triangular Prism:
  - Volume = Base Area* Height
  - **$(17.86ft^2)(13.125ft) = 234.4\ ft^3$**
- Trapezoidal Prism:
  - Volume = Base Area * Length
  - ***$Volume = 46.2\ ft^2 * 13.125ft = 606.37\ ft^3$***
- ***$Total\ Volume = 606.37\ ft^3 + 234.3\ ft^3 = 840.67\ ft^3$***



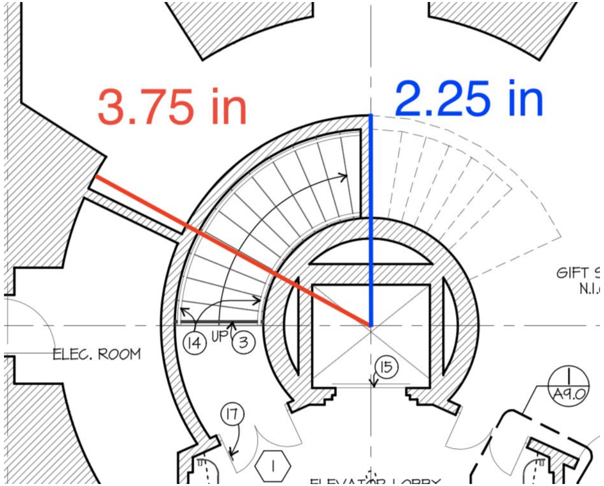
Calculating 1st floor volume...(Inner area volume)

- Since the volume for one corner is ***840.67 ft³***, then 840.67 * 4 = **3,362.68 ft^3 for all 4 corners.**
- Next we will continue to break down the floor layout by calculating the outer circular volume (red).
- The blue circle represents the space that the elevator and staircase occupy. These spaces will be calculated later.



Calculating 1st floor volume...(Inner area volume)

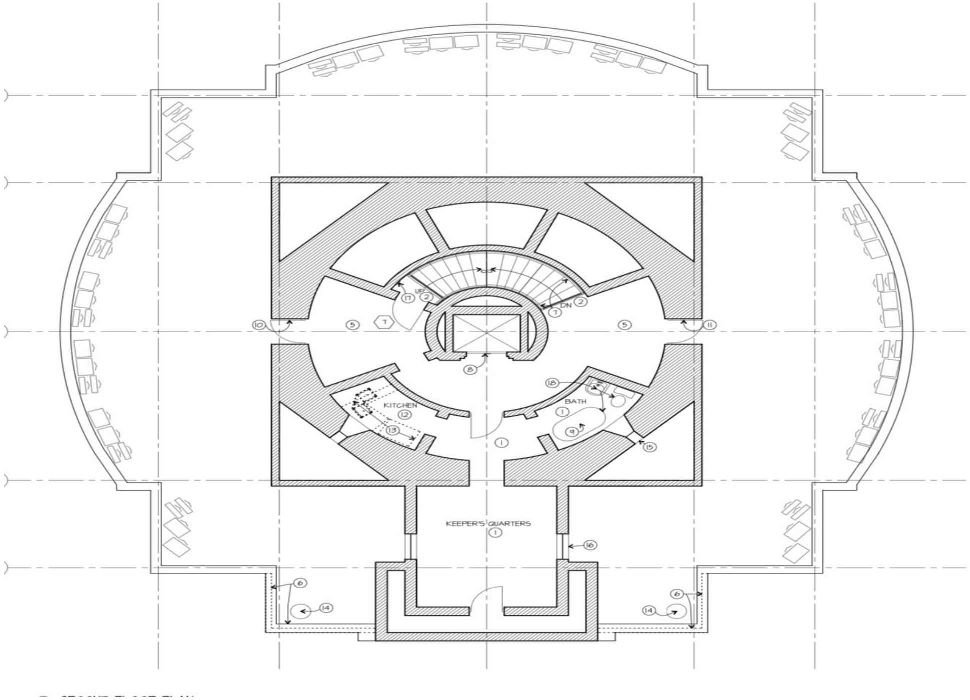
- Red Circle Radius:
  - 3.75 in or 15ft
- Blue circle Radius:
  - 2.25in or 9ft
- The volume of a cylinder is: $\pi * r^2 *$height (height=13.125ft)
  - Red cylinder volume = 9,277.5 ft^3
  - Blue cylinder volume = 3,339.9 ft^3
- **Inner area circular volume = 9,277.5 ft^3 - 3,339.9 ft^3 = 5,937.6 ft^3**



1st floor total available volume

- Total Inner area corner volume = **3,362.68 ft^3**
- Total inner area circular volume = **5,937.6 ft^3**
- Total outer area volume = **23,887.5 ft^3**
- **Total area for 1st floor is 33,187ft^3**

2nd Floor Calculations...



2nd Floor calculations (continued)

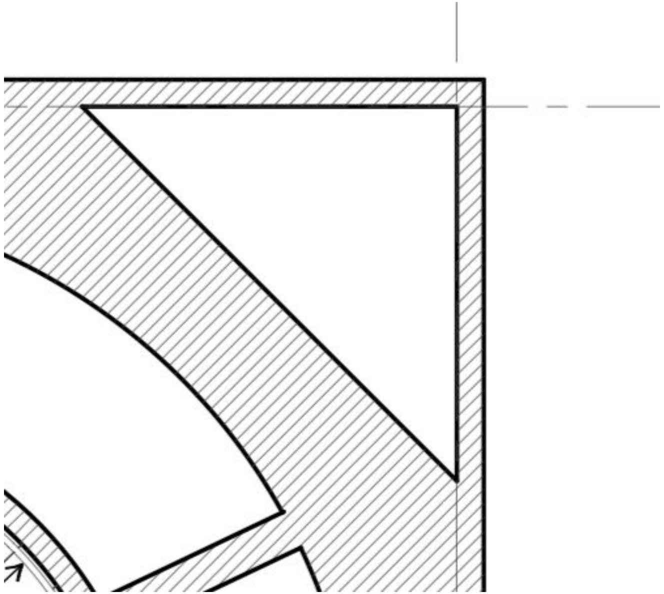
- As we can see from the previous slide, the layout for the second floor is similar to the first
- According to my measurements, the dimensions for both floors are identical so I will be using the same information from the previous slides except for the height since the height from 2nd floor to the 3rd has changed.
- Also the corners for the inner area are no longer pentagonal shaped but rather triangular so I will be adjusting my calculations accordingly

2nd floor calculations (Outer area)

- The outer area volume for the second floor will be excluded because there are no walls, therefore we wouldn't be able to hold pokeballs in this area.

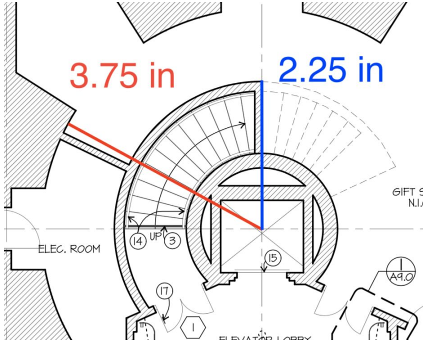
2nd floor calculations (inner area)

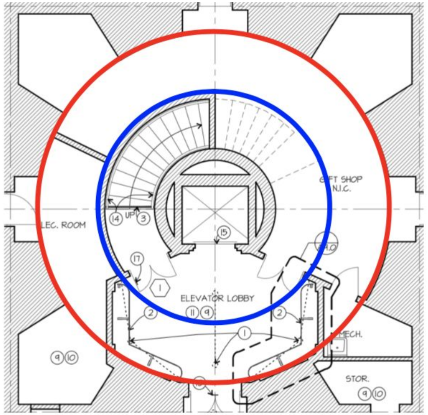
- As previously mentioned, one aspect of this floor layout that has changed is the corners of the inner area
- We will consider these corners as Triangular prisms and calculate the volume
- Using the formula to calculate triangular prism we get:
    - V = Base Area * Height = 11.25 ft * 40.46 ft^2
    - V = 455.17ft^3
    - **V for 4 corners = 455.17 * 4 = 1820.7ft^3**



2nd floor calculations (inner area)

- Next, using the previous methods, we will calculate the cylinder shaped volume of the inner circular area since dimensions are equal.
- The volume of a cylinder is: $\pi * r^2 * height$ (height=11.25ft)
    - Red cylinder volume = 7,952.15 ft^3
    - Blue cylinder volume = 2,862.77 ft^3
- **Inner area circular volume = 5,089.38 ft^3**



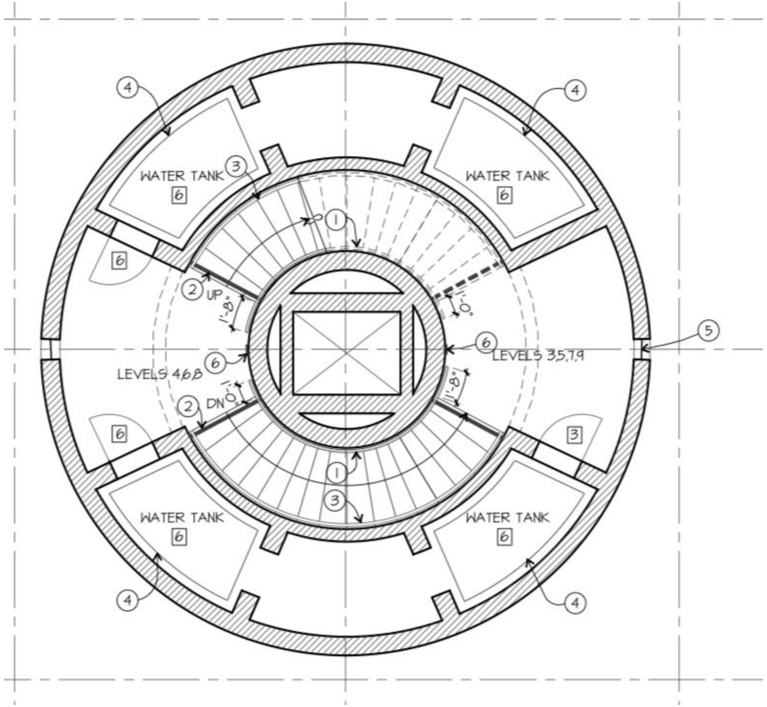


2st floor total available volume

- **Total volume is = 5,089.38 ft^3 + 1820.7ft^3 = *6,910.08 ft^3***

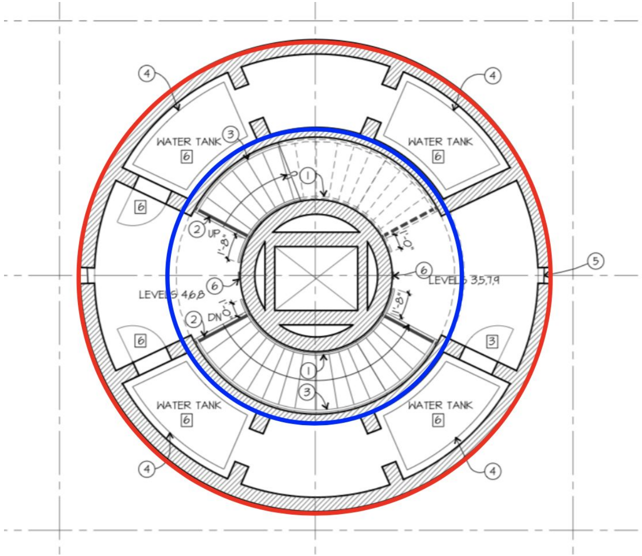
Floors 3-10 calculations

- The calculations for 3-10th floors have the same radius dimensions as the circular inner areas as the previous floors so we will utilize the same methods.
- Again the only difference we will have to adjust for when calculating each of these floors is the height.



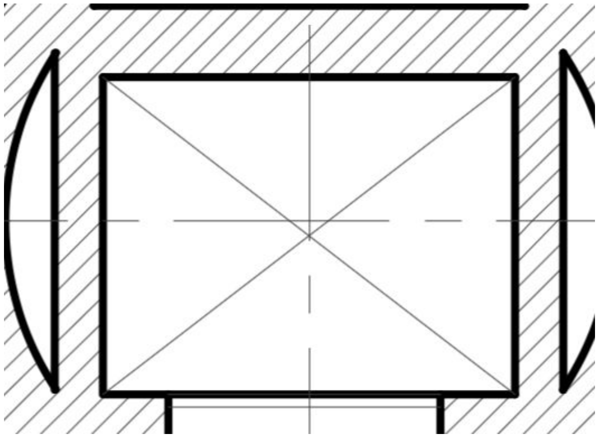
Floors 3-10 calculations

- Formula: $\pi * r^2 *$height (height= varies by floor)
  - Outer cylinder: $(15ft)^2$ * pi * height
  - Inner cylinder: $(9ft)^2$ * pi * height
  - V = Outer Volume - Inner Volume
- 3rd floor(height = 11.7ft): 5,292.95 ft^3
- 4th floor (height = 12ft): 5,428.67 ft^3
- 5th floor(height = 10ft): 4,523.89 ft^3
- 6th floor(height = 13.875ft): 6,276.9 ft^3
- 7th floor(height = 11.91ft): 5,387.95 ft^3
- 8th floor(height = 13.66ft): 6,179.63 ft^3
- 9th floor(height = 16.5ft): 7,464.42 ft^3
- 10th floor(height = 10.5ft): 4,750 ft^3
- **Total: 45,304.41 ft^3**



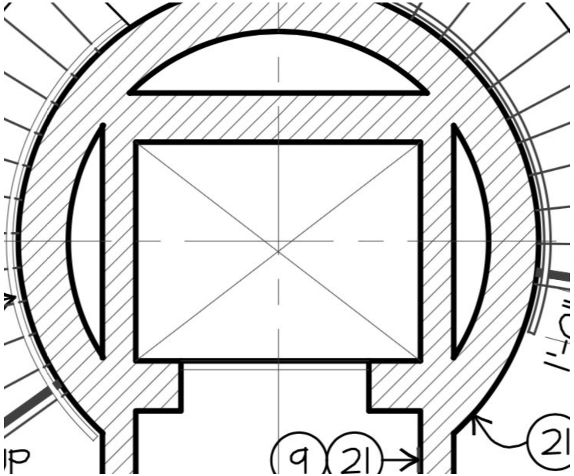
Elevator

- Length = 5.5ft
- Width = 4 ft
- Height = 8ft - I don't have the height measurement for the elevator but I’m going to assume it is about 8 ft.
- Elevator volume 176 ft^3



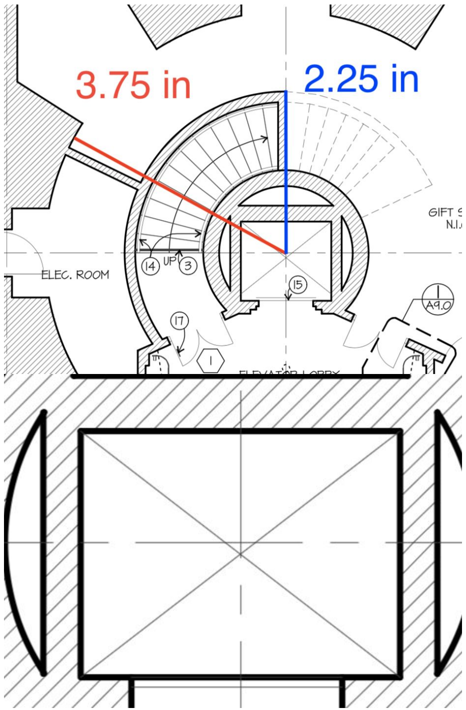
Elevator shaft

- According to the drawing the elevator shaft appears to end at the 11th floor, this means that we can assume the height of the shaft to be 146ft.
- I measured the radius of the shaft to be 1 inch or 4 ft when scaled up
- The volume of the elevator shelf would therefore be:
    - $V = 4^2 * pi * 146 = 7{,}338.76\ ft^3$
- Next we subtract the volume that the elevator takes up
    - **Volume = 7338.76 -176 = 7,162.76 ft^3**



Staircase

- If we consider the staircase volume area without the stairs for a moment then we can see that the info needed for this part has already been calculated (1st floor inner area & elevator shaft)
- Therefore if adjust for the height(146ft)
    - Staircase volume = 37,152.47 ft^3 - Elevator shaft volume
    - V = 37,152.47 ft^3 - 7,338.76 ft^3 = ***29,813.71 ft^3***
- Since I don't know the volume of the stairs I will assume that the staircase in the staircase area cannot take up more that 30% of the total space, Therefore:
    - **Staircase volume = 20,869.6 ft^3**



Total Available space in coit tower

- If we now add everything up then we get that the total available space in coit tower is:
  - 113,609.85 ft^3
- However because we will be sphere packing, the densest packing can only occupy 74% of available space, therefore:
  - 113,609.85 ft^3 * .74 = **84,071.3 ft^3**

Final Answer

- Now we simply divide available space by the volume that a pokeball occupies:
  - (84,071.3) ÷ (.007743) = 10,875,715 pokeballs
- **Team Rocket would get away with 10,875,715 pokeballs**