# Angular velocity of the windmill

With the given data set of the time frame number of rotations

- In the first step, we calculated the RPM of the windmill, as we already had durations & rotations. We did it by dividing the number of rotations by the duration in minutes.
- In the second step, we calculated the angular displacement(theta) for each time frame by multiplying the RPM by 2π.
- Then in the third step, we Calculated the angular velocity for each time frame by dividing the angular displacement by the duration in seconds.

Time	Duration(mins)	Rotations	RPM	Theta	Angular velocity
6.00 am - 6.30 a	30	600	20	3769.911184	125.6637061
6.30 am- 8 am	90	1600	17.77777778	10053.09649	111.7010721
8 am - 9.30 am	90	1000	11.11111111	6283.185307	69.81317008
9.30 am - 10.30	60	500	8.333333333	3141.592654	52.35987756
10.30 am - 12.30	120	1600	13.33333333	10053.09649	83.7758041
12.30 pm - 2.30	120	1550	12.91666667	9738.937226	81.15781022
2.30 pm - 3.30 p	60	1000	16.66666667	6283.185307	104.7197551
3.30 pm- 4.00 pr	30	1200	40	7539.822369	251.3274123
4.00 pm - 4.30 p	30	1000	33.33333333	6283.185307	209.4395102
4.30 pm - 5.30 p	60	1200	20	7539.822369	125.6637061
5.30 pm- 6.00 pr	30	800	26.66666667	5026.548246	167.5516082
				Avg angular velcity	125.7430393

After getting the Angular velocity, we proceeded to create the histogram plot with the angular velocity values on the x-axis and the frequency of occurrence on the y-axis.
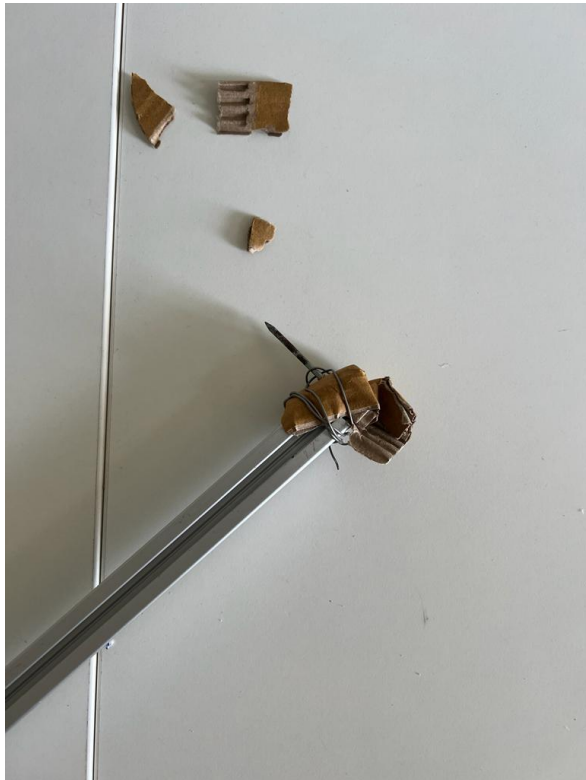
Windmill Angular Velocity Histogram
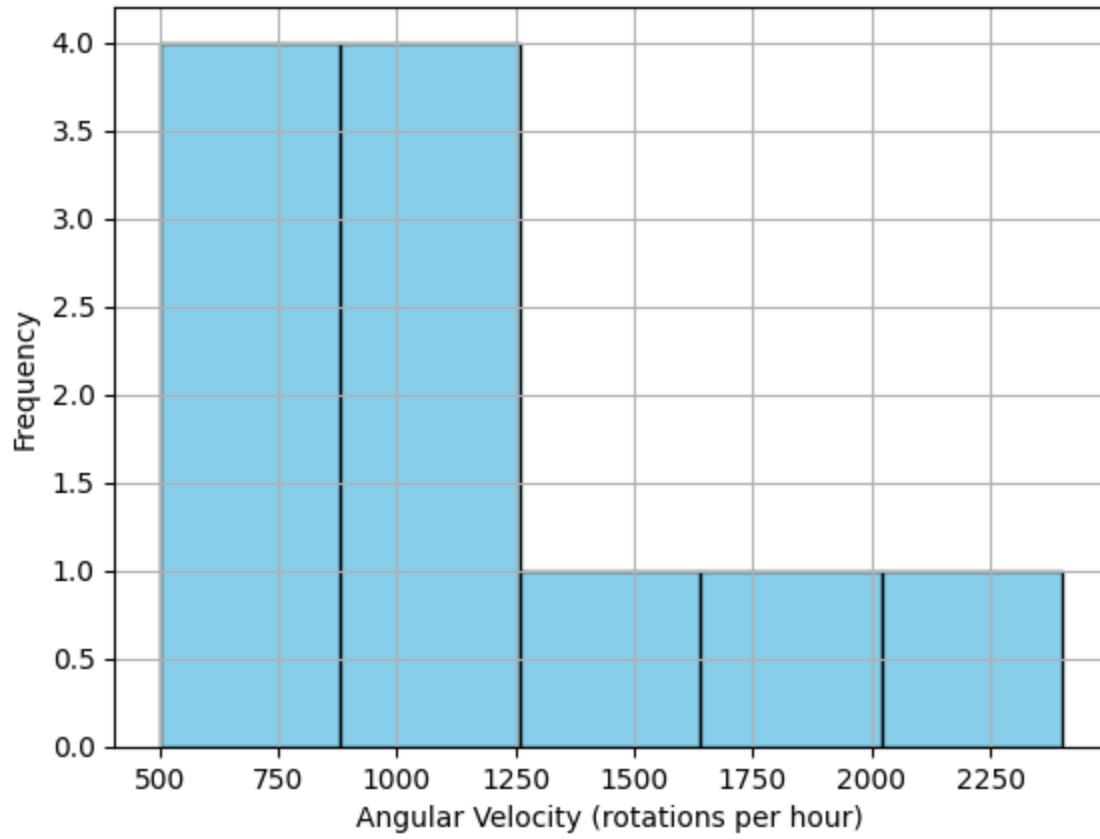
Q2
Creating Windmill

We used simple tools like Paper, cardboard, steel wire, glue & stand to create our own working windmill. Following are the images of the making of the Windmill

The final and functional windmill looked like this

- Our next time was to measure the time taken by the windmill to complete the 'x' number of rotations. We took an interval of 5min for a total of 30min and the results were as follows

Time	Duration(mins)	Rotations
11:30 am – 11:35 am	5	585
11:35 am – 11:40 am	5	545
11:40am – 11:45 am	5	439
11:45 am – 11:50 am	5	762
11:50 am – 11:55 am	5	560
11:55 am – 12:00pm	5	380

All the calculations for both questions are present in the Excel sheet given below

⊞ Angular velocity of the windmill

To calculate the wind speed using the windmill

Let's take into consideration,
11:30 am - 11:35 am
RPM - 117
Angular Velocity - 735.13
Blade Radius - 17cm i.e 0.17m

- Calculating the **Blade tip speed** using the RPM and blade radius:

  Blade Tip Speed = RPM * 2π x blade radius / 60
  $\qquad\qquad$ = 117 x 2π x 0.17 / 60
  $\qquad\qquad$ = 1.08 m/s

- Now calculating **TSR (tip speed ratio)**

  TSR = blade tip speed / (Angular Velocity x blade radius)
  $\qquad$ = 1.08 / (735.13 x 0.17)
  $\qquad$ = 0.003

- Calculating the wind speed
  Wind speed = Blade tip speed / (TSR)
  $\qquad\qquad$ = 1.08 / (0.003)
  $\qquad\qquad$ = 360 m/s