Date of Lab____________ Date of Submission 10/2/18

Laboratory Report Cover for #12 Lab

Title Circular Motion and Centripetal Force

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Summary

We learned the relationship between the rotation radius and ω^2 by changing the length of string, and the relationship between the *Centripetal Force and ω^2 by changing the weights. They were both proportional to each other. From the theory of Centripetal Force which is $F = mr\omega^2$, those relationship must be proportional, so we had great experiments.

This lab helped us understand about circular motion and centripetal force.

* horizontal component of Tensional force

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words

Teacher's Comments

Good experiment, analysis and summary. Discuss with Teacher about "centripetal force" and your "opinion".

1 Due	2 Summary		4 Results Tables	5 Fig. Graphs	6 Results Summary Table	7 Discussion & Opinions	8 Clearness	9 General
+			+	++	+	+	+	++

* Use this form as a cover sheet.

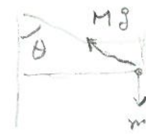
* Submit your reports by the seventh day after your lab.

Results

Experiment 1:

Mass of Rubber (m) 7.73x10^-3 kg
Mass of 4 Washers (M) 2.91x10^-2 kg
θ= 74.6°
F'= 0.275N

7.73 g
29.1 g
7.28g/washer



Mg cosθ = mg
θ = cos⁻¹(m/M)
= 74.6°

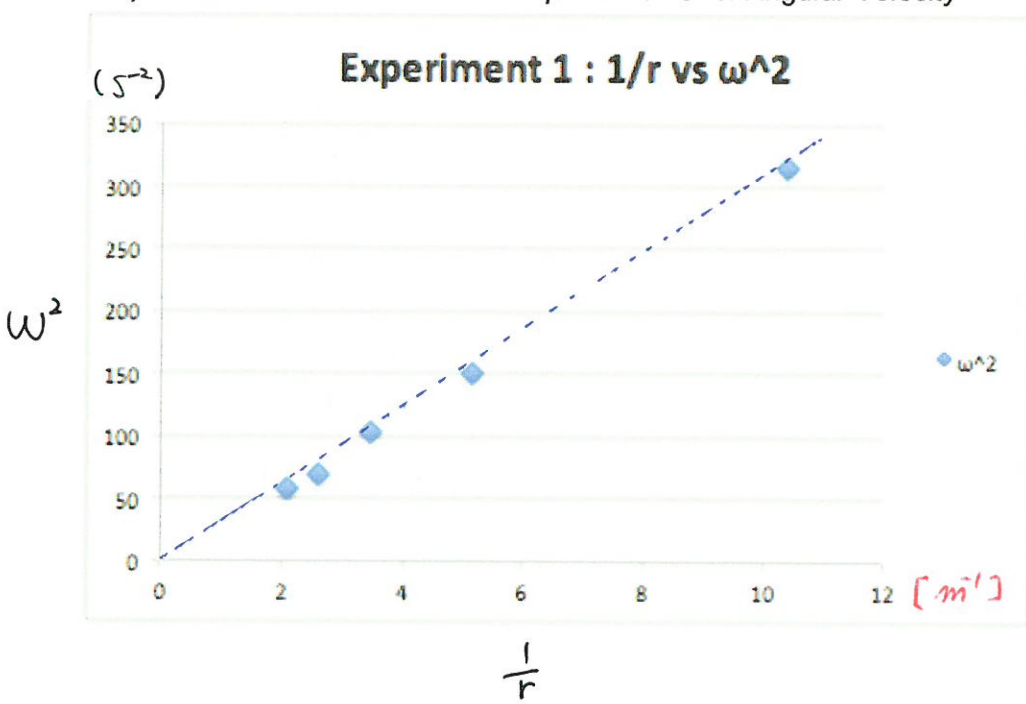
F' = Mg sinθ
= 29.1×10³×9.8×sin74.…
= 0.275 (N)

Table 1 : Changing the Length of String

No.		1	2	3	4	5
Length of String	m	0.100	0.200	0.300	0.400	0.500
Radius (r = Lsinθ)	m	0.096	0.193	0.289	0.386	0.482
1/r	m^{-1}	**10.4**	**5.18**	**3.46**	**2.59**	**2.07**
(L-r) / L x 100	%	4.00	3.50	3.66	3.50	3.60
Time to take 20 circuits (20T)	s	7.08	10.3	12.5	15.2	16.5
Period (T)	s	0.354	0.517	0.627	0.761	0.824
ω^2	**s^-2**	**315**	**151**	**103**	**68.4**	**58.7**

$\omega = \frac{2\pi}{T}$

Graph 1 : One Half of Radius vs. Square Power of Angular Velocity



$F' = m r \omega^2$

$\omega^2 = \left(\frac{F'}{m}\right)\frac{1}{r} = \left(\frac{0.275}{7.73\times10^{-3}}\right)\frac{1}{r}$

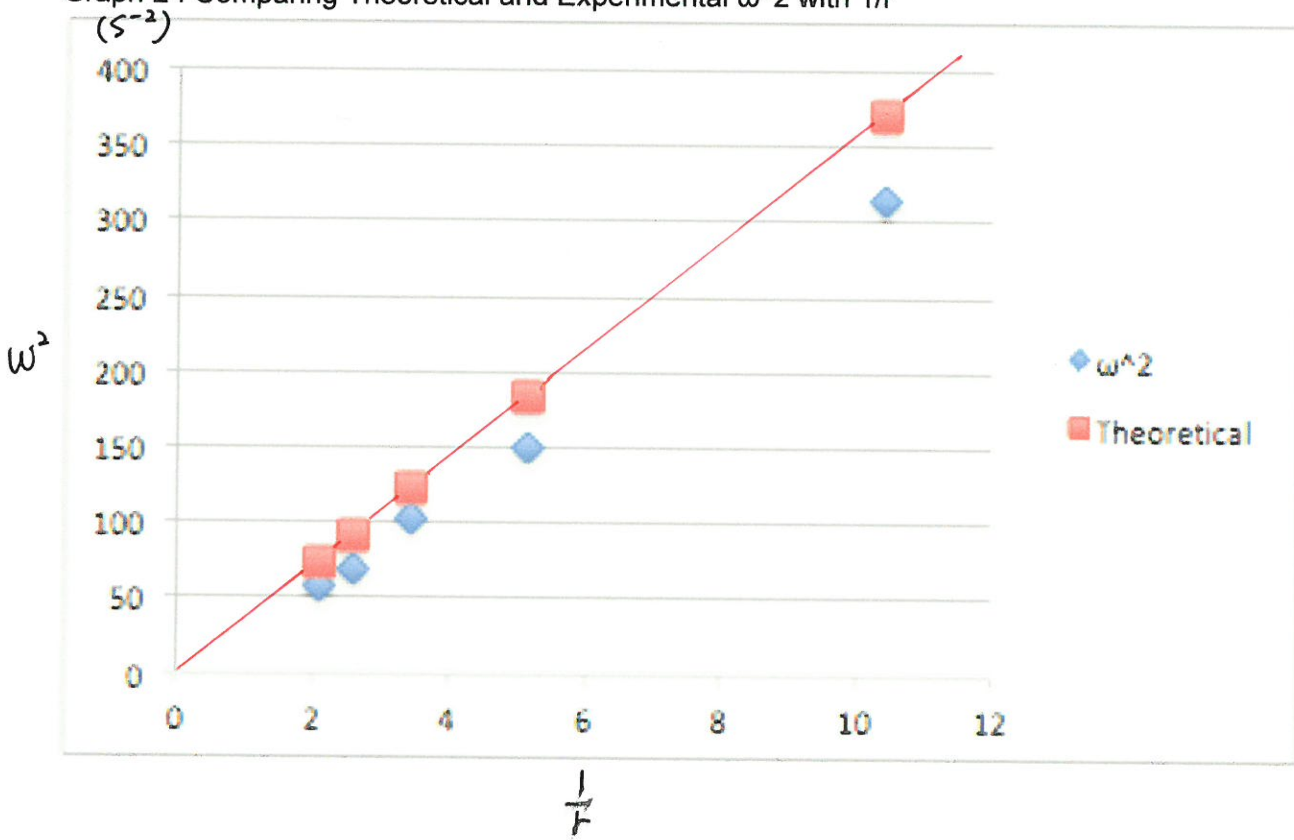
$= 35.6 \cdot \frac{1}{r}$

$F' = Mg\cos\theta$

Table 2 : The Relationship of 1/r and ω^2 and Theoretical ω^2

1/r	ω^2 (s^-2)	Theoretical ω^2 (s^-2)	% Error (%)
2.07	58.7	73.6	20.2
2.59	68.4	92.1	25.7
3.46	103	123	16.3
5.18	151	184	17.9
10.4	315	370	14.9

Graph 2 : Comparing Theoretical and Experimental ω^2 with 1/r



$F' = Mg\cos\theta$

F' could actually smaller because of the friction between the string and the edge of glass tube.

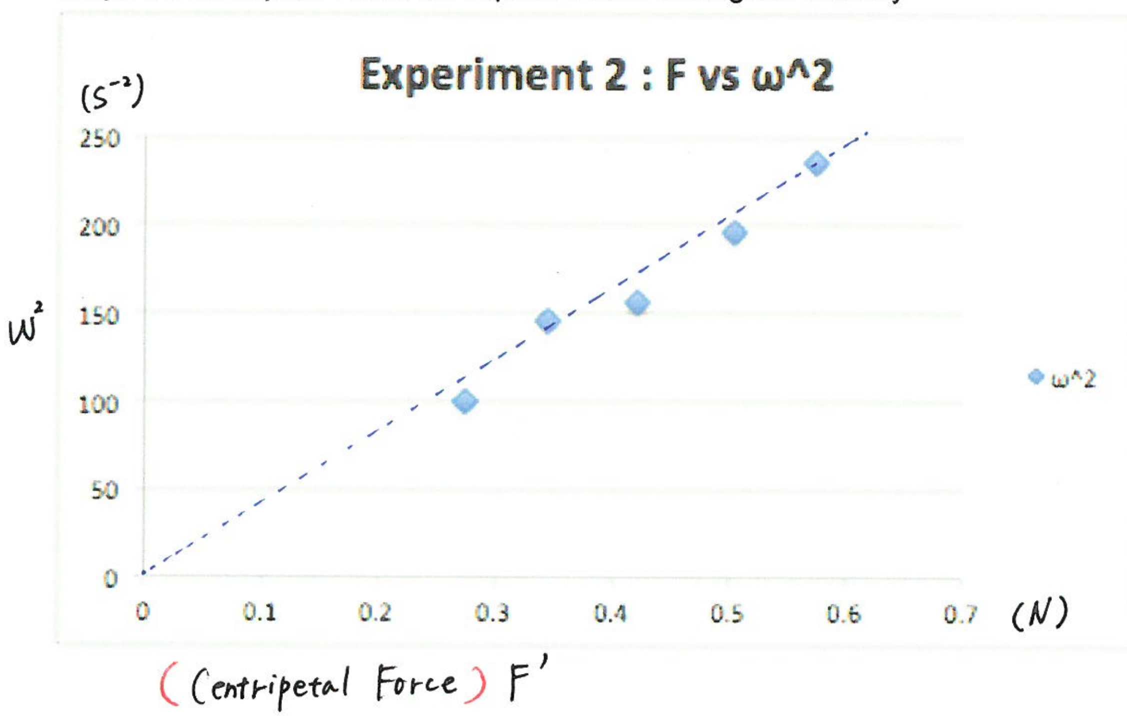
Experiment 2 :

Mass of Rubber (m) 7.73x10^-3 kg
Length of String 0.30m

Table 3 : Changing the Number of Weight

No.		1	2	3	4	5
# of Washers		1 4	2 5	3 6	4	5 ← ?
Total Mass of Washers (M)	kg	0.0290	0.0360	0.0437	0.0520	0.0591
Angle between String and Glass Tube (θ)	°	74.6	77.6	79.1	81.5	82.5
Centripetal Force (F')	**N**	**0.274**	**0.345**	**0.421**	**0.504**	**0.574**
Radius (r)	m	0.289	0.293	0.295	0.297	0.297
(L-r)/L x 100	%	3.67	2.33	1.67	1.13	1.00
20T	s	12.5	10.4	10.1	8.97	8.19
T	s	0.627	0.520	0.503	0.449	0.41
ω^2	**s^-2**	**100**	**146**	**156**	**196**	**235**

Graph 3 : Centripetal Force vs. Square Power of Angular Velocity



The horizontal component of tensional force

$F' = m r \omega^2$

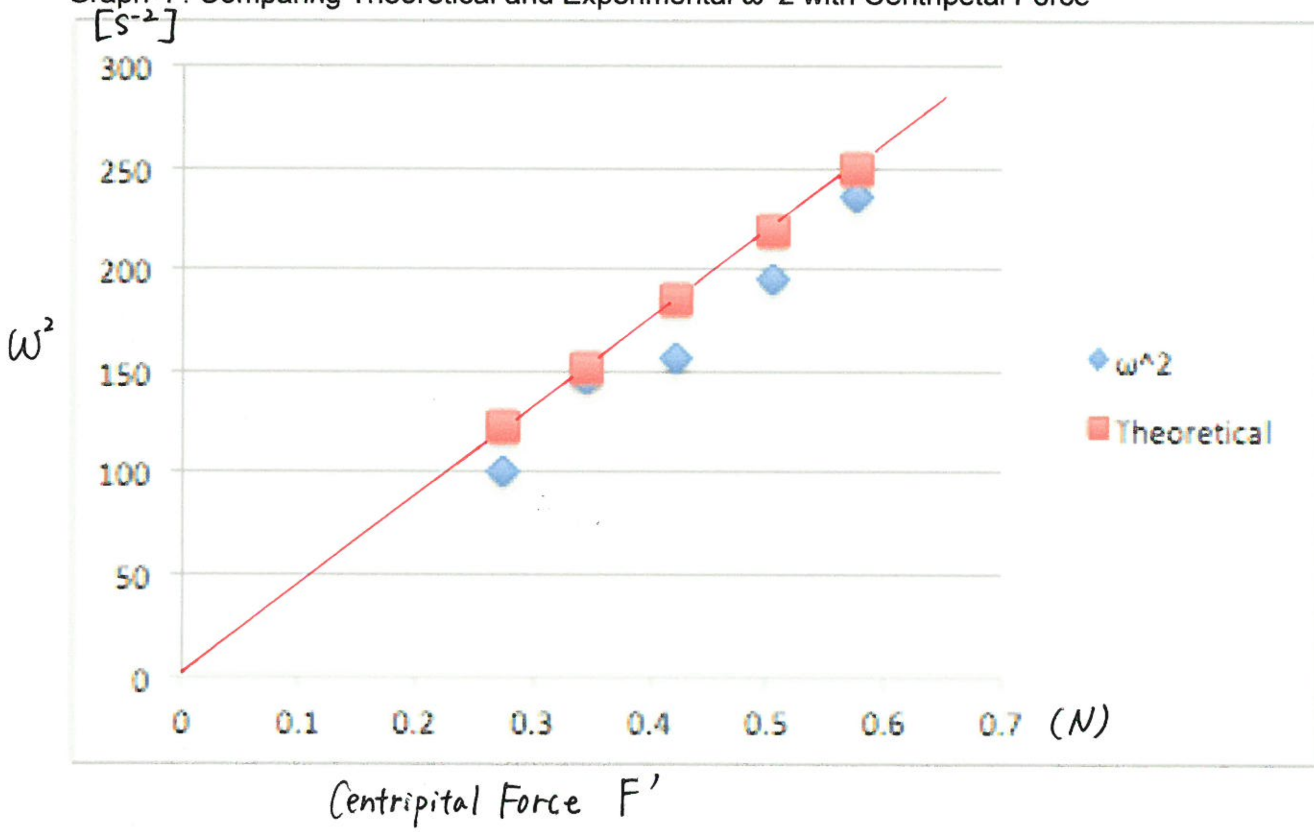
$= 7.73 \times 10^{-3} \times r \omega^2$

$\omega^2 = \frac{129}{r} F'$

Table 4 : The Relationship of F' and ω^2

F' (N)	ω^2 (s^-2)	Theoretical ω^2 (s^-2)	% Error (%)	r
0.274	100	123	18.7	0.289
0.345	146	152	3.95	0.293
0.421	156	185	15.7	0.295
0.504	196	219	10.5	0.297
0.574	235	250	6.00	0.297

Graph 4 : Comparing Theoretical and Experimental ω^2 with Centripetal Force



inverse or reciprocal

Discussion

As you can see from Graph 1, the square ~~power~~ of angular velocity (ω^2) is almost proportional to the ~~one half~~ of radius (1/r). This reason can be known from the theory of centripetal force, which is F' = mrω^2. When the centripetal force (F') and mass of rubber (m) stay the same, radius (r) and square power of angular velocity (ω^2) are inversely proportional to each other. Therefore, one half of radius (1/r) and square power of angular velocity (ω^2) must be proportional to each other. You can also know this from Graph 2. As the graph is labeled, this graph is comparing the theoretical square power of angular velocity (ω^2) and experimental square power of angular velocity (ω^2). The theoretical square power of angular velocity (ω^2) increases constantly as one half of radius (1/r) increases.

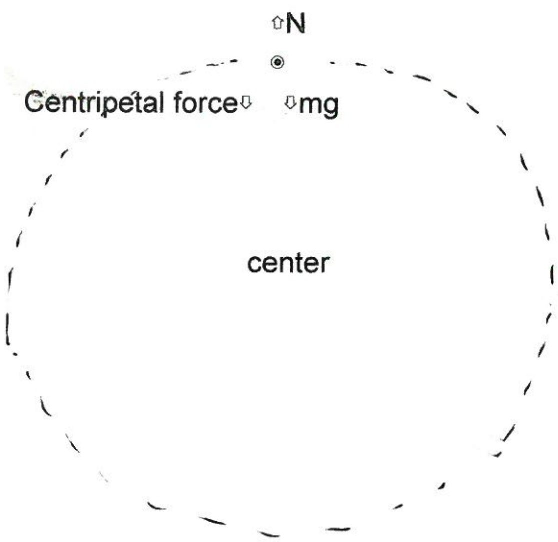
From Graph 3, the centripetal force (F') and the square power of angular velocity (ω^2) are almost proportional to each other. This reason can also explained from the theory of centripetal force. If the centripetal force (F') increases, the square power of angular velocity (ω^2) increases in the same proportional because m and r does not change in this case. You can know this more clearly from Graph 4. The theoretical square power of angular velocity (ω^2) has a straight line, which means the square power of angular velocity is proportional to the centripetal force (F').

From Table 2 and Table 4, my experimental square power of angular velocity (ω^2) has some error, and sometimes % error is huge like 10-20 %, but you can know that they are not so huge error when you see Graph 2 and Graph 4. Therefore, I think the lab we did was pretty good, but these errors are come from our time counting of 20 circuits and also our swinging. It is very difficult to have a perfect period in the experiment, swinging constantly in experiment is also difficult because there is some air resistance and human's force from their hands.

Opinion

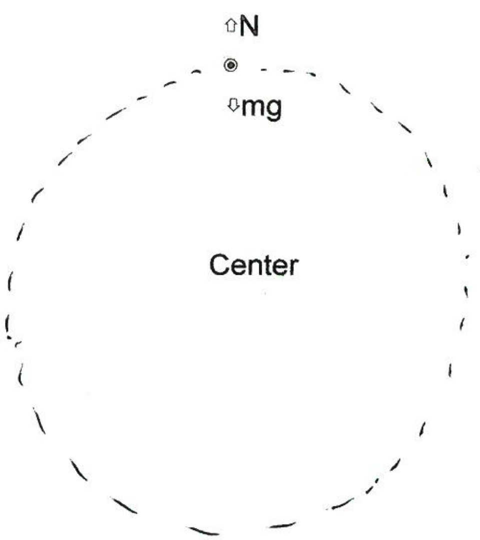
This lab helped me to understand about centripetal force a lot. Because I was not fully understood about it, I messed the coordinates of forces on my test which I took before. I just needed to think about which force stands for centripetal force which often points to the center.

<u>Before this lab</u>



N = Centripetal Force + mg

<u>After this lab</u>



N - mg = - (Centripetal Force)

Ferris Wheel.