Lab 8: How does mass, Velocity, and radius affect an object spinning in a circle?

Purpose:

To explore the relationship between centripetal Force and different variables like mass, velocity, and radius that contribute to centripetal force.

Theory

Uniform circular motion is the motion of an object in a circle at a constant velocity. Although the velocity of the object is constant, the direction is constantly changing in the circle, and thus there is acceleration. This specific type of acceleration, where the magnitude of velocity is constant but its direction is changing is called centripetal acceleration and is determined with the following equation:

$$a_c = \frac{v^2}{r}$$

a_c = Centripetal Acc

V = Velocity of object

r = radius of circle.

Since there is an acceleration, there must be a force, so using Newton's Second Law, the formula for Centripetal Force is given by:

$$F_c = m\left(\frac{v^2}{r}\right)$$

F_c = C. force
V = Velocity
r = radius.

$V = \frac{2\pi r}{t}$

Velocity is equal to displacement over time, ~~since~~ ~~the circum~~ in so in a circle that displacement would be the circumference, over the time for one revolution

Procedure - Part 1

1. Measured ~~?~~ .20cm of string between rubber stopper and tubing.
2. Clipped Alligator clip 1 cm below tubing.
3. ~~4~~. Tied mass hanger and 45g of weight to string.
*4. Added more alligator clips to ~~tubing~~ string to prevent it from going into tubing
*5. Practiced swinging rubber stopper in a horizontal circle such that bunch of aligator clips stopped right at tubing.
6. Once comfortable w/ speed, recorded time needed for 20 cycles (complete revolutions) to pass.
7. Calculated time for 1 revolution ~~has~~ by dividing time recorded by number of cycles timed for (20).
9. Calculated Centripetal force ~~by~~ ~~[illegible]~~ & using ~~[illegible]~~ weight of hanging mass.
8. Calculated Average velocity using average period.
10. Repeated ~~step~~ steps 3 through 9 for 60g, 70g, and 80g of weight.

Part 2

11. Measured mass of rubber stopper.
12. Calculated expected velocity for rubber stopper using its measured mass.
13. Determined percent error between expected and measured period.

Part 3

14. ~~Tied 70g~~ of Placed 70g on 5g mass hanger.
15. Measured .1 m for ~~[illegible] of [illegible] distance of~~ st length of string between rubber stopper and tubing.
16. Repeated steps 4-9 for .15m, .2m, and .3m.

Calculations & Graphs

~~Velocity~~ Tangential Velocity

$$V = \frac{2\pi r}{t}$$ (eq:tvelocity)

v: velocity
r: radius of circle
t: time for 1 revolution

Sample Calc
Using part 1 data w/ 50g of weight.

$$V = \frac{2\pi r}{t} = \frac{2\pi(.2m)}{0.34261}$$
$$\bar{V} = \boxed{3.666\ m/s}$$

Avg
Sample using Part 1 50g

$$\frac{0.334 + 0.3515}{2}$$
$$\bar{t} = 0.3426$$

% Error Sample using Part 2 50g

$$\left|\frac{m - a}{a}\right|$$
$$\frac{.3426 - .5071}{.5071} \cdot 100$$
32.4%

Centripetal Force

$$F_c = \frac{mv^2}{r}$$ (eq:centriforce)

Fc: centripetal force
m: mass of object
V: ~~Velo~~ tangential velocity of object
r: radius of circle

Sample Calc
~~Using~~ Using expected velocity in part 2 w/ 50g

$$F_c = \frac{mv^2}{r} = \frac{(0.012\ kg)(2.858\ m/s)^2}{.2m}$$
$$F_c = \boxed{0.49\ N}$$

Graphs
Part 1
Fc vs Velocity
Vic
(fig:FcvVelo)
Part 1
Table Lab
(tab:part1tab)
Part 2
Table lab
(tab:part2tab)
~~Part 3~~
Table + (tab:...)
Graph (fig:...)

Lab 8

Questions.

1) We had more trouble with the heavier masses.

2). The biggest source of error in the lab was not following directions properly. Instead of swinging the ~~mass~~ rubber stopper such that the alligator clip remained 1 cm below the tubing, we ~~swung the stopper.~~ attached MORE alligator clips and swung the stopper such that the alligator clips lined up exactly with the tubing. This made our measured velocity faster and more consistent than it should have been.

3) Besides not following directions properly, we. part 2 was more difficult since it took some effort to swing the stopper ~~at~~ with just the right speed such that the alligator clip remained 1 cm below the tubing.

4) Our own data shows ___ correlation, but ~~basso~~ using algebra, we'd expect the centripetal force to increase as the ~~velocity~~ velocity increased.

the horizontal axis.) *What type of trend line should be matched with this data do you think?*

Mass	Trial 1 Period	Trial 2 period	average period	average velocity	Fc (N)
50g	0.334	0.3515	0.3426	3.666	~~490~~
60g	0.329	.353	0.341	3.685	[illegible]
70g	0.332	.354			
80g	0.358	.3295			

.49N

.588N

.686N

.784N

$$\frac{mv^2}{r} = 50 \cdot 9.8$$

$$v = \frac{2\pi(.2)}{.341}$$

$$\frac{2\pi r}{t} = v$$

$m = 15.95g \rightarrow .01595 kg$

yours might be different for the

t that equal to mv^2/r to solve for

12g but you use your mass for this

$$(.01595 kg)(9.8) = \frac{(.01595)v^2}{.15}$$

$$mg = \frac{mv^2}{.2m}$$

Mass	Theoretical velocity	Theoretical period	Actual period (from part 1)	%Error
50g	2.478	.5071	.3426	
60g				
70g				
80g				

Radius	Trial 1 Period	Trial 2 Period	average period	average velocity	Fc (N)
0.1	.273	.252			
0.15	.7	.4575			
0.2	10.[illegible]	.5015			
0.3	11.25	11.36			