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Experiment Name and No.: OSCILLATIONS, EXPT-2

# Part A- Coupled Pendulum

**Aim:** To find out the different time periods of a coupled pendulum

**Setting up the experiment:**

I used a stand that was present in the balcony of my house to tie the string to.

I used identically shaped coconuts with the same mass to make the pendulums and their mass was 500 grams.

The balance was made using a plastic cup (in which milk is sold). Using a weighing machine, I weighed a divided some rice into bags of 10g, 20g to add weight accordingly and change the weight kept on the balance.



This is a video of me calculating T3: [Video link](#)

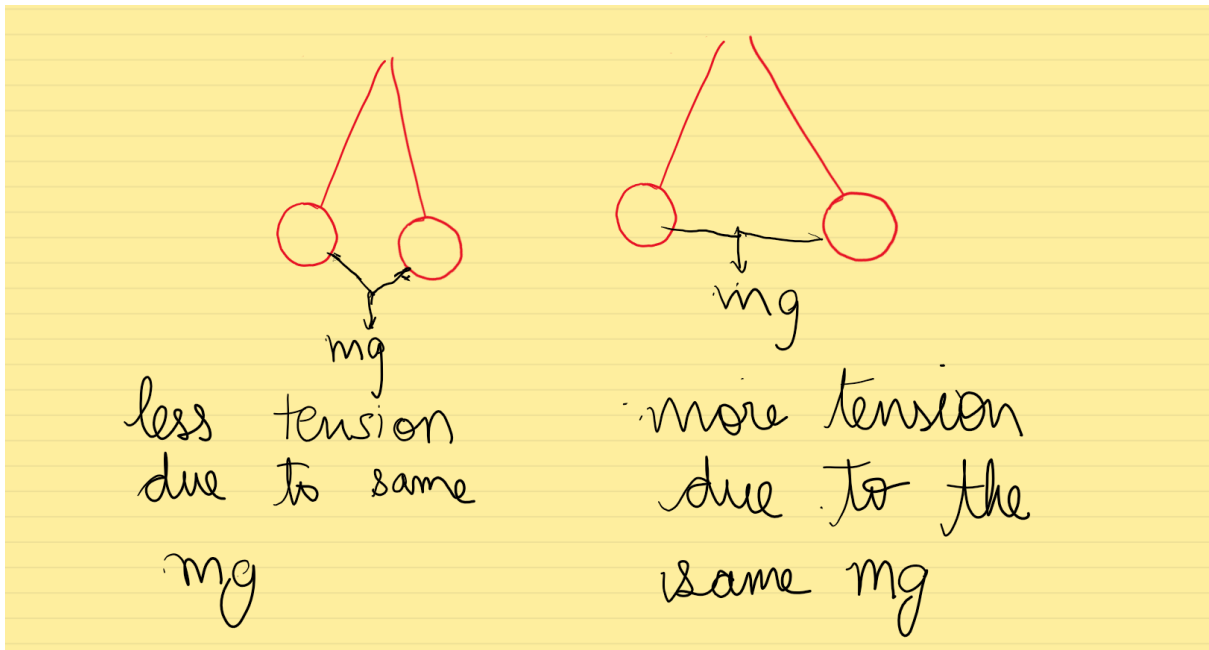
The time periods I found were

Mass in the balance (in grams)	T1(in seconds)	T2(in seconds)	T3(in seconds)
0	2.36	2.27	73.45
10	2.35	2.27	60.35
20	2.36	2.26	52.02
30	2.36	2.26	46.15
40	2.34	2.25	42.1
50	2.37	2.22	38.5
60	2.35	2.19	35.1
70	2.37	2.185	32.05
80	2.4	2.18	30.35
90	2.36	2.17	29.4
100	2.33	2.17	28.5

Inference:

T1 was found to be almost similar for all the different masses, with the mean value = 2.359 seconds and the largest deviation being only 0.04 seconds which could easily have been caused due to human error. From this I concluded that T1 was more or less constant. Also, the values sometimes increased and decreased indicating that it was neither increasing nor decreasing effectively. I understood that when both the pendulums were moving in phase, the mass did not influence it.

T2 was found to be decreasing gradually in very small amount unlike T1 which increased and decreased alternatingly. From this I concluded that T2 was decreasing. I also saw that this time the mass in the balance acted like a spring and when the two pendulums were at opposite directions (phase difference  $\pi$ ), it acted like a spring that was extended to its maximum amplitude which gave some extra force to bring the bobs of the pendulum close together. I also noticed that it was forming a sort of Simple Harmonic Motion such that the force on the bobs by the tension due to the mass depended on the displacement between the two bobs and the Force always in the negative direction of displacement.



This also meant that, more the mass on the balance, the more the “mg” and therefore the Time period should reduce due to the extra force provided by the mass in the balance. This is also shown in the findings with the gradual decrease.

T3 was decreasing when I increased the mass and the decrease was also large enough to be clearly observed. I noticed that this time, the experiment involved the transfer of energy from one pendulum to the other and vice versa. On further observation, I noticed that the mass of the balance had the same physical importance as the spring’s constant and as the mass increased, the force with which they caused motion increase and therefore the other pendulum could be made to move easily hence reducing the time between two consecutive stops of one of the pendulums.

I plotted T1, T2 and T3 and this is what I got: [Graph1](#)

Other things I noticed

- 1. When the length of the pendulum was reduced to half of its original length, all the readings reduced.  
Keeping no mass in the pendulum, the table below shows the comparison between the earlier values and the new values

Old value of T1	New value of T1(when length reduced)
2.36 seconds	1.78 seconds

Old value of T2	New value of T2(when length reduced)
2.27 seconds	1.72 seconds

Old value of T3	New value of T3(when length reduced)
73.45 seconds	41.17 seconds

- 2. When the separation between the individual pendulums was decreased to half its original length and all other parameters were kept constant (no mass in the pendulum), the following values were observed:

Old value of T1	New value of T1(when separation reduced)
2.36 seconds	1.954 seconds

Old value of T2	New value of T2(when separation reduced)
2.27 seconds	1.81 seconds

Old value of T3	New value of T3(when separation reduced)
73.45 seconds	32.21 seconds

- 3. This meant that the effect of decrease in length of the pendulum had a greater affect than the decrease in separation between the two pendulums. Both of them were directly proportional to T1, T2 and T3.
- 4. When I tried to increase the tension in the upper string, I saw that as the tension increased the time periods decreased.

# PART B – Pendulums with multiple frequencies

**Aim:** To study the patterns formed by a pendulum with multiple frequencies

## Setting up the experiment:

I used the same beam to support the thread in this experiment too as used in the previous experiment. I set  $L_1 = 90\text{cm}$  and  $L_2 = 114\text{cm}$ .

I used a bottle to hold the powder. The powder was rice flour. To make sure that I could see the patterns formed on the floor, I took on my mother's old black sari for the necessary contrast required to see the pattern properly.



I tried the experiment at an angle of 45 degree from the plane and found that the line along which the pendulum moved changed continuously till a certain extent and the opposite change occurred.

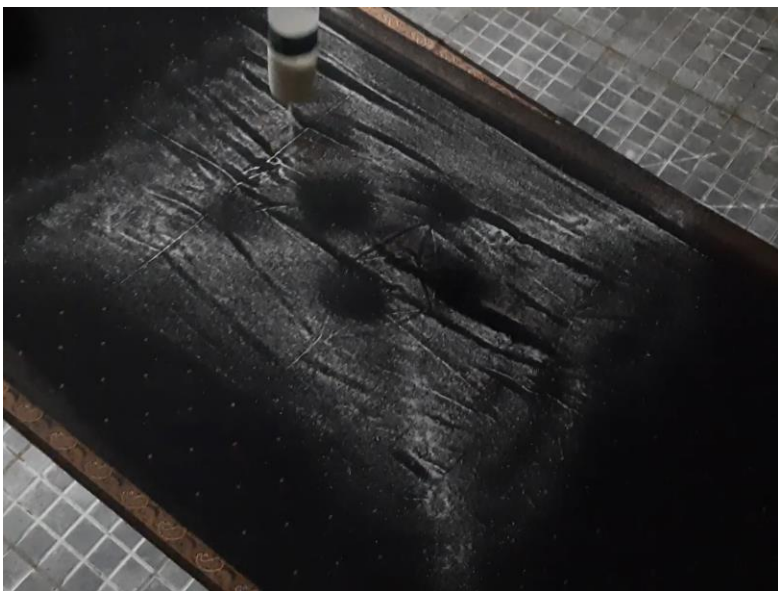
## Videos:

for 30 degrees: [Video2](#)

for 45 degrees: [Video3](#)

for 60 degrees: [Video4](#)

**These were the patterns I got:**

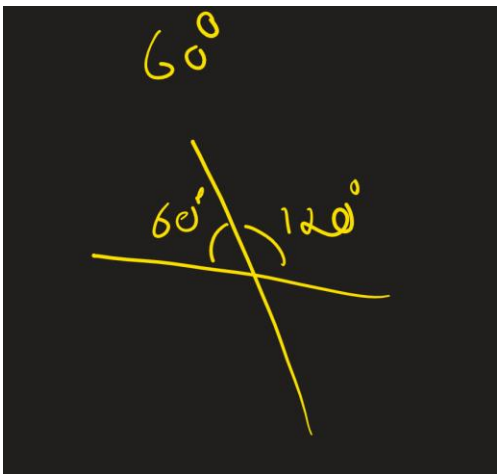
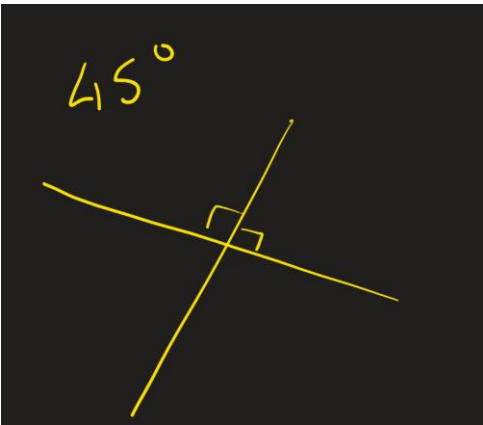
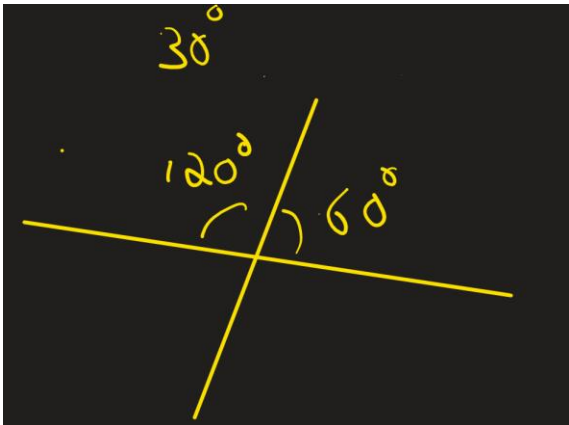






**Observations and descriptions:**

I noticed that the angle formed between the major axes for the various angles of the pendulum



I also noticed that the two major axes of the pattern had almost the same length.

I also noticed that the length of the axes was highest for 60, then 45 and finally 30

The shape formed at 45 degrees was almost like a square and the other two were like Rectangles

**Other observations:**

I tried the experiment for 0 degree and 90 degree – the time period of the oscillations I got were:

Degree	Time Period
0	2.345
90	2.729

Then I checked for the effect of variation of L2/L1:

L1(in cm)	L2(in cm)	L2/L1	Time Period (0 degree)	Time Period (90 degree)
90	114	1.267	2.345 seconds	2.729 seconds
90	75	0.833	1.972 seconds	2.462 seconds
90	40	0.444	1.534 seconds	2.219 seconds

This means that as the ration L2/L1 decreases the value of time period decreases for the pendulum.

# Acknowledgements

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