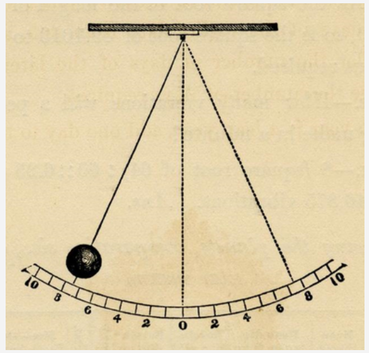
SPRING 2024
CCIoT

8 MAY 2024

SIMPLE PENDULUM



IoT Pendulum Experiment: Determining Acceleration Due to Gravity

SPRING 2024
CCIoT

8 MAY 2024

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TA: Vedant Nipane

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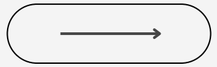
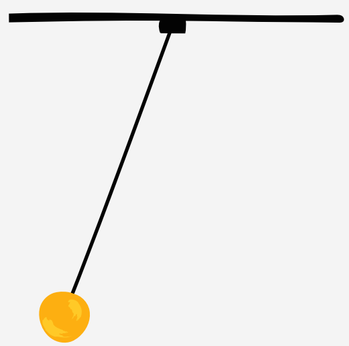
RISHABH PATNAIK (2022102014)



CONTENTS

SIMPLE PENDULUM

$$T = 2\pi\sqrt{\frac{L}{g}}$$

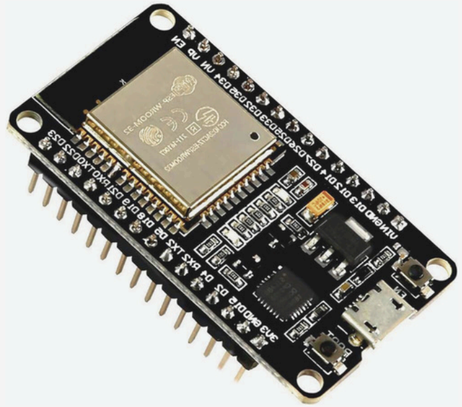


T = period
L = length of the pendulum
g = acceleration due to gravity

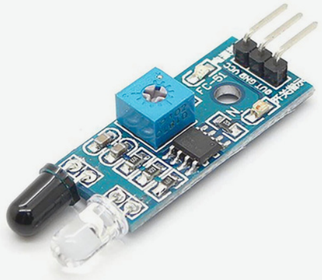
ASSUMPTIONS

- Diameter of bob is negligible compared to length of string
- String is massless and is strong enough not to stretch appreciably
- The displacement of pendulum bob is small, that is, the angle is less than 15 degrees

COMPONENTS

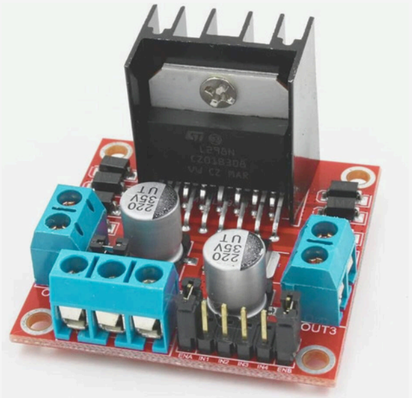


ESP32



IR SENSOR

SERVO MOTOR

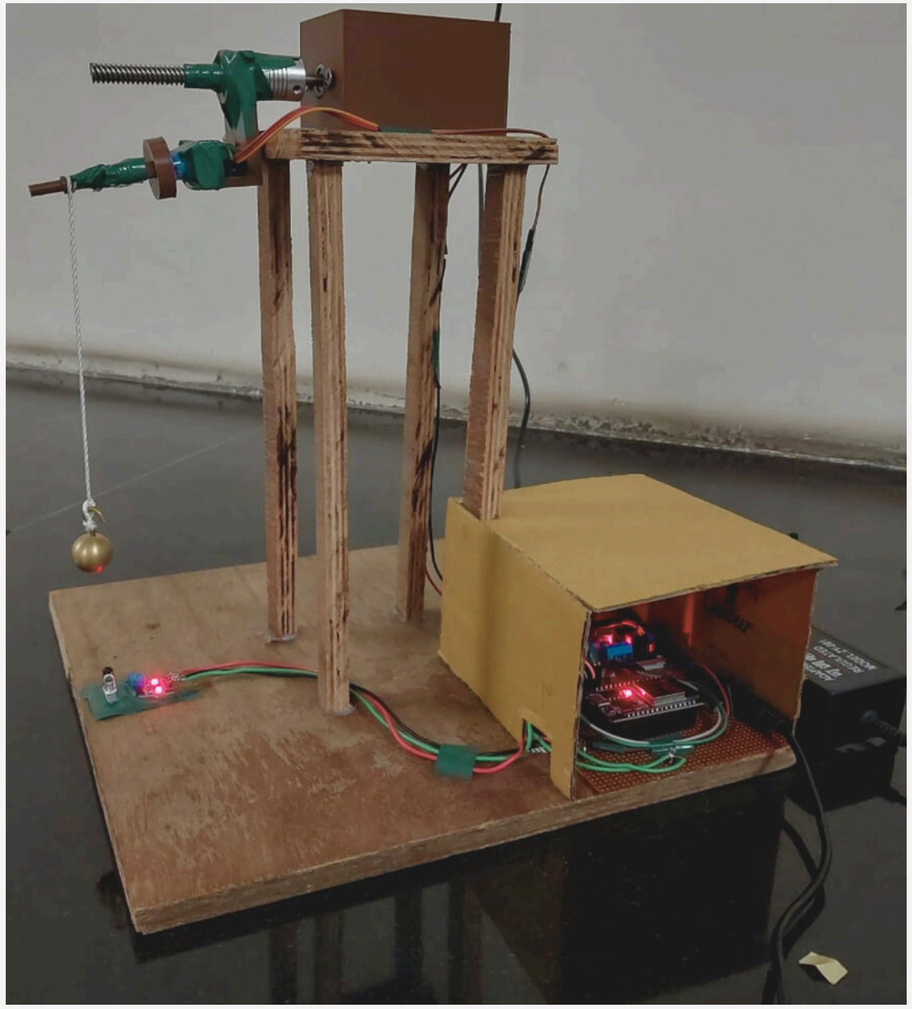


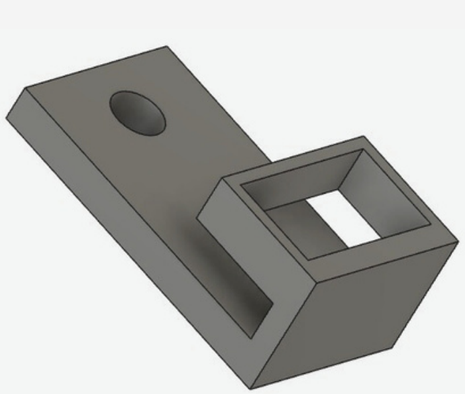
L298N MOTOR DRIVER

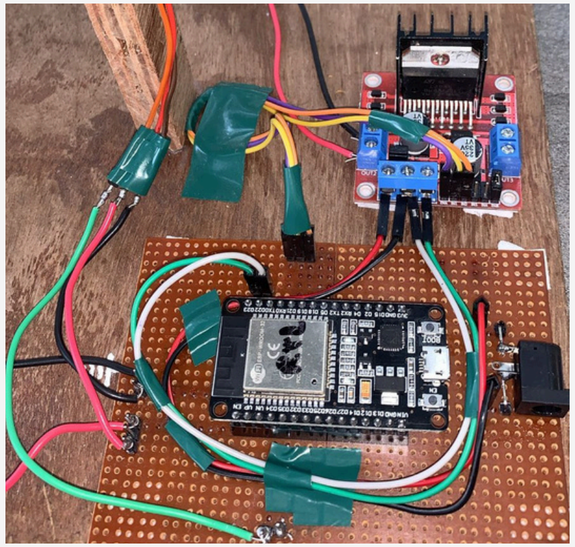
DC MOTOR

IMPLEMENTATION

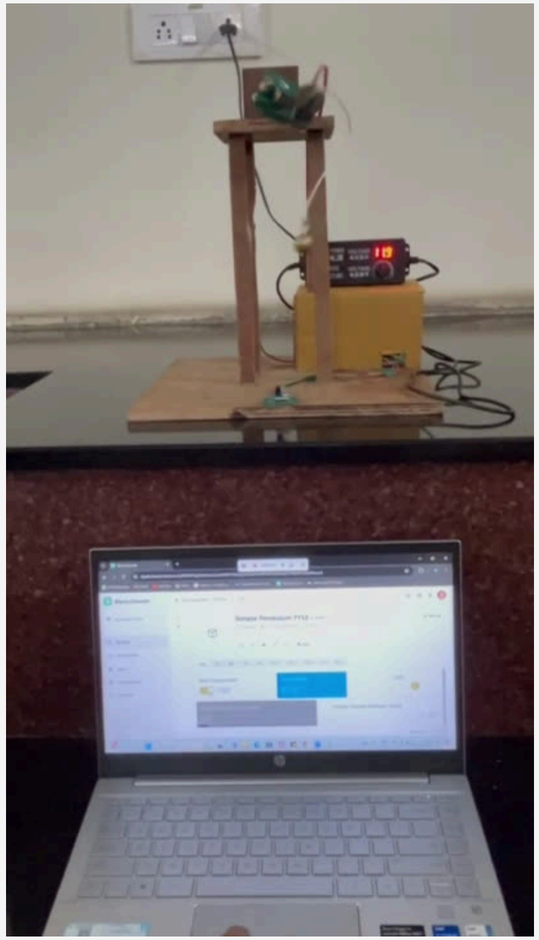
DESIGN

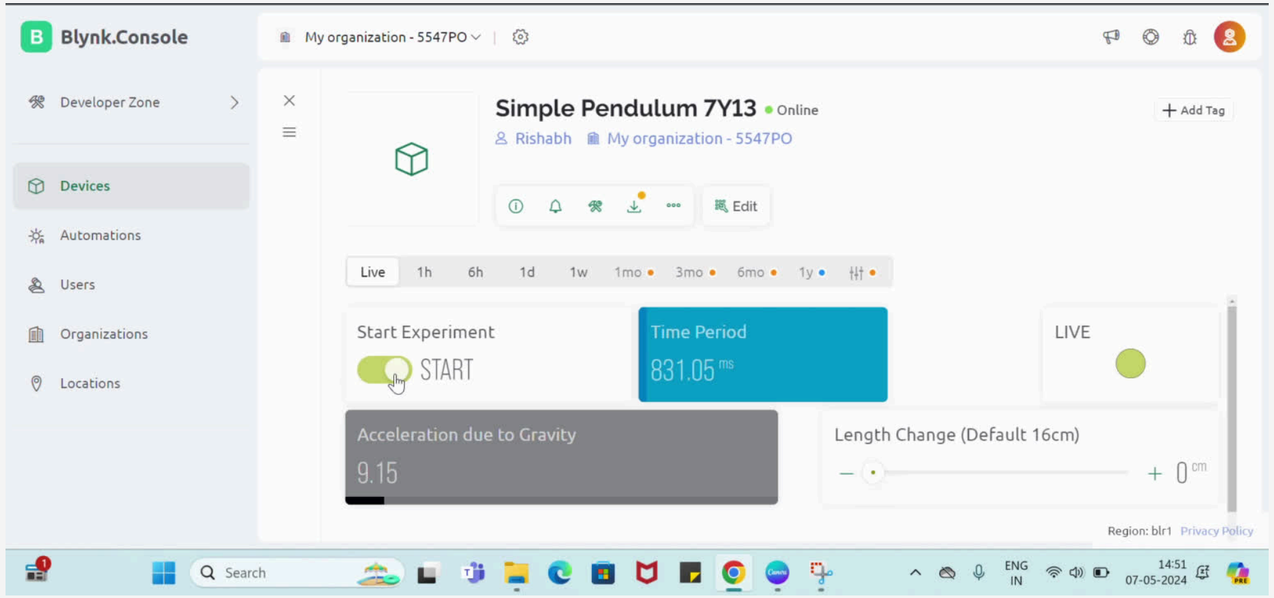






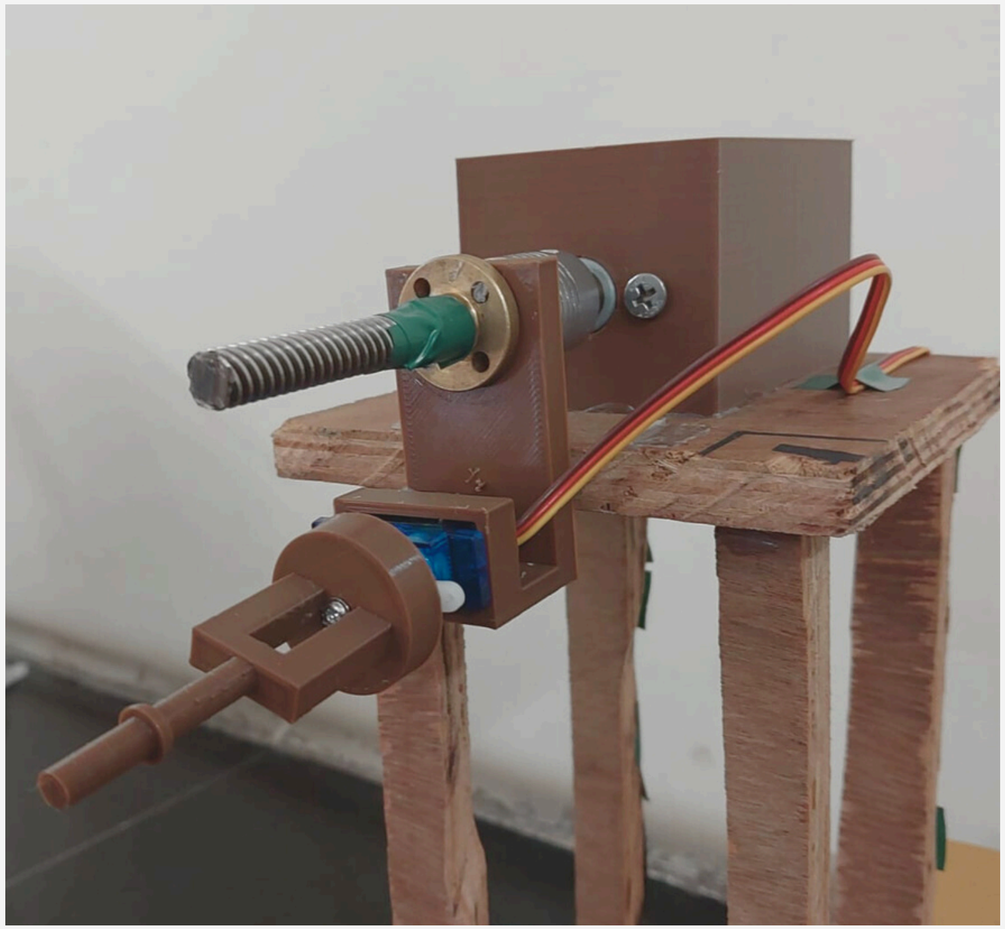
WORKING




Blynk.Console
My organization - 5547PO
Developer Zone
Devices
Automations
Users
Organizations
Locations
Simple Pendulum 7Y13
Online
Add Tag
Rishabh
My organization - 5547PO
Edit
Live
1h
6h
1d
1w
1mo
3mo
6mo
1y
Start Experiment
START
Time Period
831.05 ms
LIVE
Acceleration due to Gravity
9.15
Length Change (Default 16cm)
0 cm
Region: blr1
Privacy Policy
Search
ENG
IN
14:51
07-05-2024

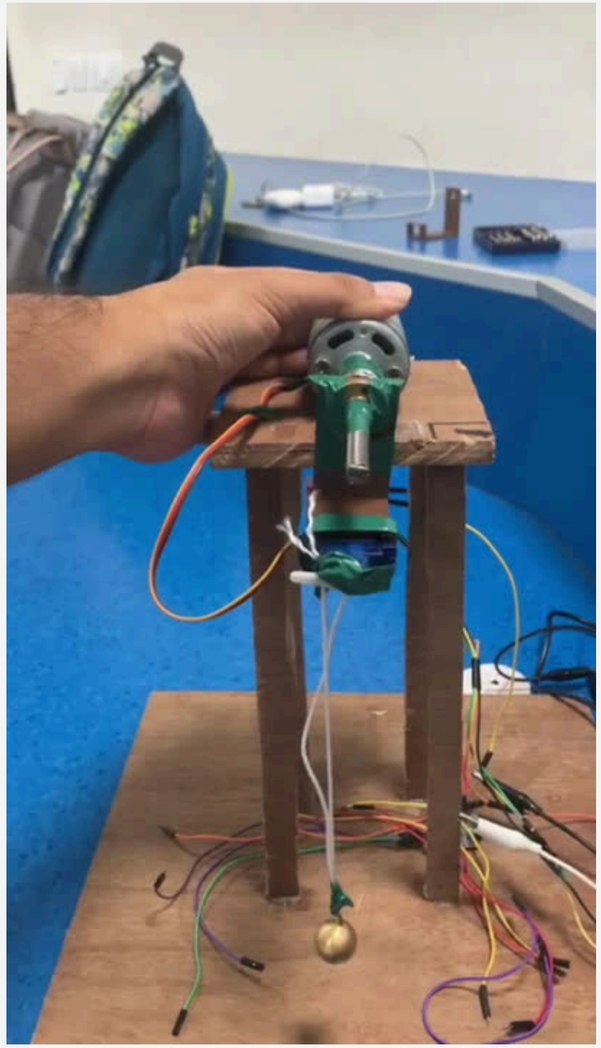
INITIATION OF PENDULUM

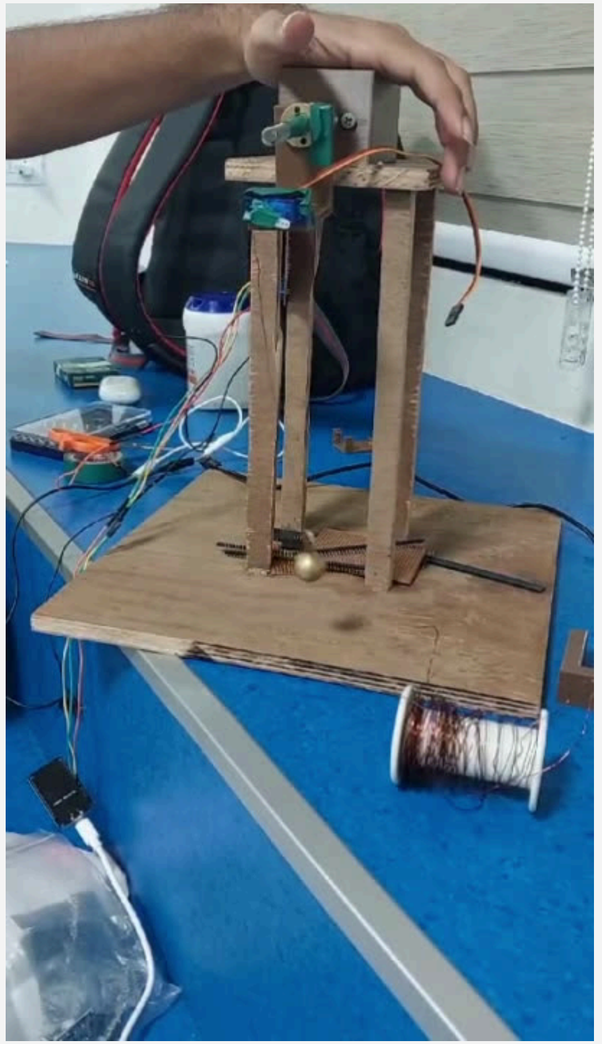
INITIATION



WORKING

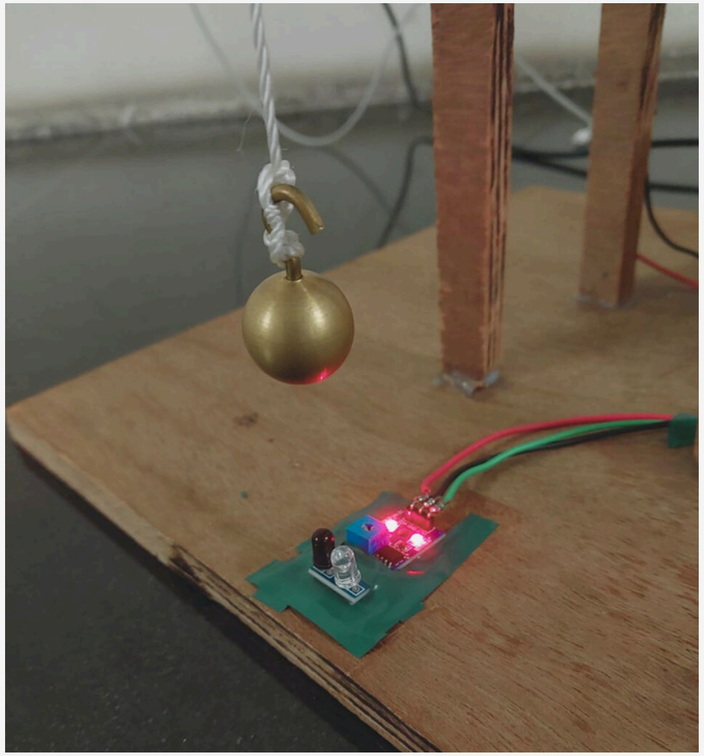
- We have employed a DC motor to rotate the L-Rod, to which the pendulum is attached.
- The motor rotates slightly in one direction and then reverses, thereby initiating the motion of the pendulum

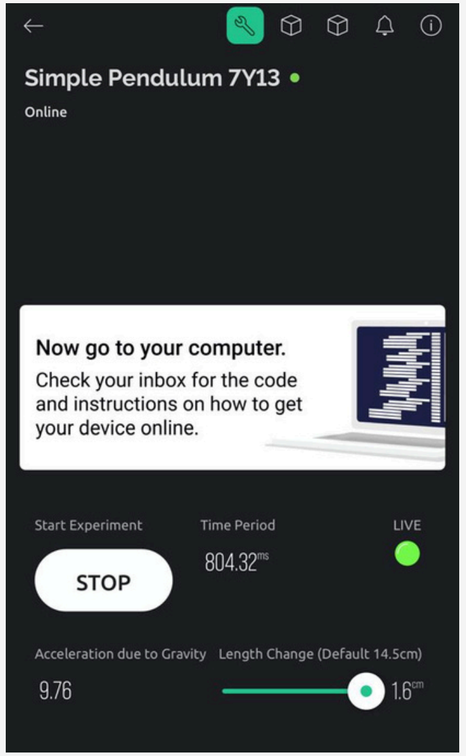




MEASURING TIME PERIOD
&
ACCELERATION DUE TO GRAVITY

COMPUTATION





WORKING

- As the pendulum swings to and fro, the IR sensor detects the bob and calculates time period using micros() function in the Arduino IDE

CHANGING LENGTH OF STRING

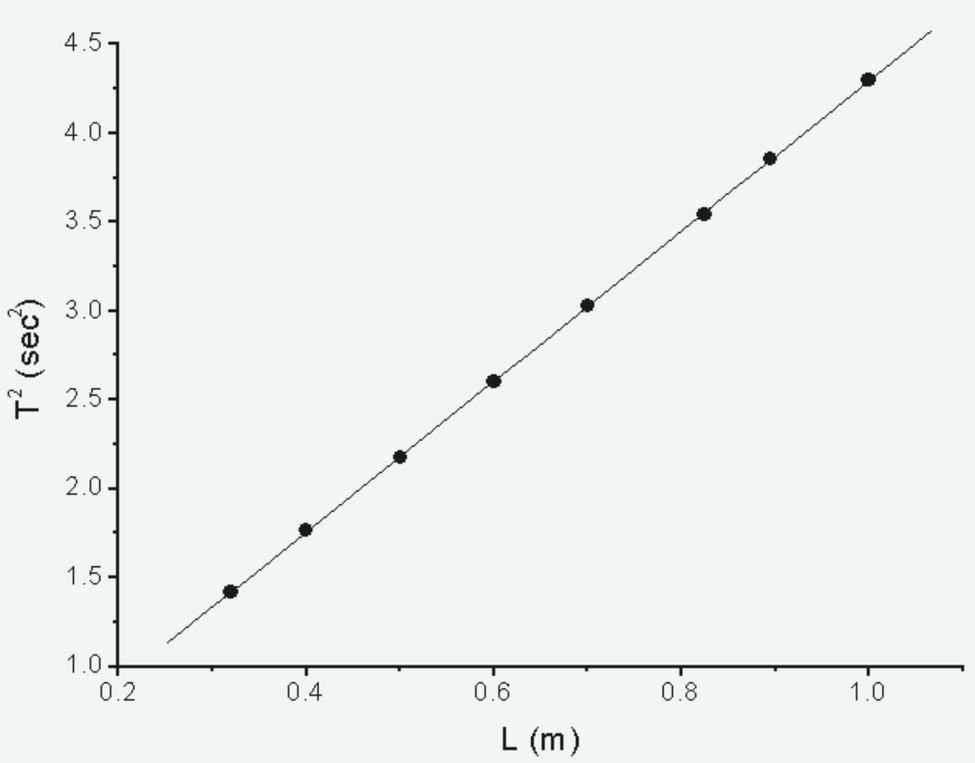
CHANGING LENGTH

WORKING

- We have employed a Servo Motor to change the length of pendulum string.
- The servo motor rotates the extension rod attached to it.
- As it rotates, the string is wound/unwound around the rod, thus changing its length.

DATA ANALYSIS

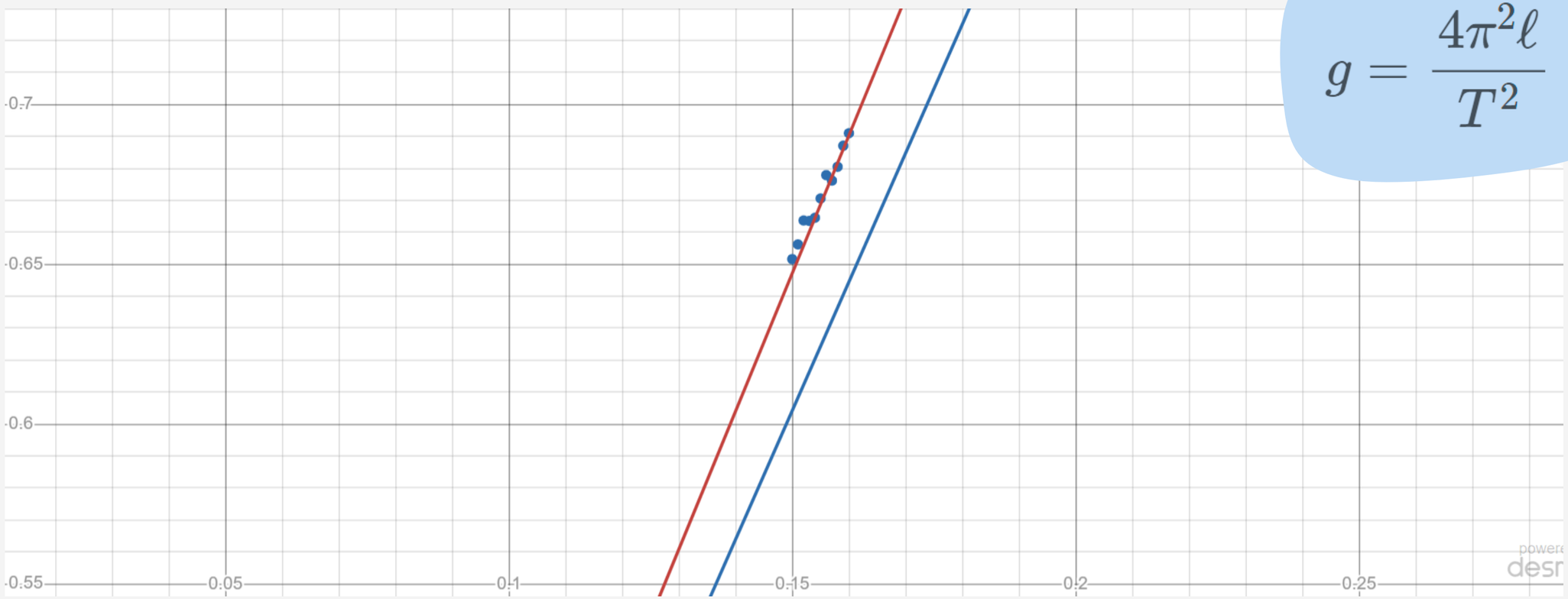
TIME PERIOD VS LENGTH



L	T	g
15 cm	807.23 ms	9.09 m/s^2
15.2 cm	814.61 ms	9.04 m/s^2
15.4 cm	815.23 ms	9.15 m/s^2
15.6 cm	823.34 ms	9.08 m/s^2
15.8 cm	824.92 ms	9.17 m/s^2

GRAPH

$$g = \frac{4\pi^2 \ell}{T^2}$$



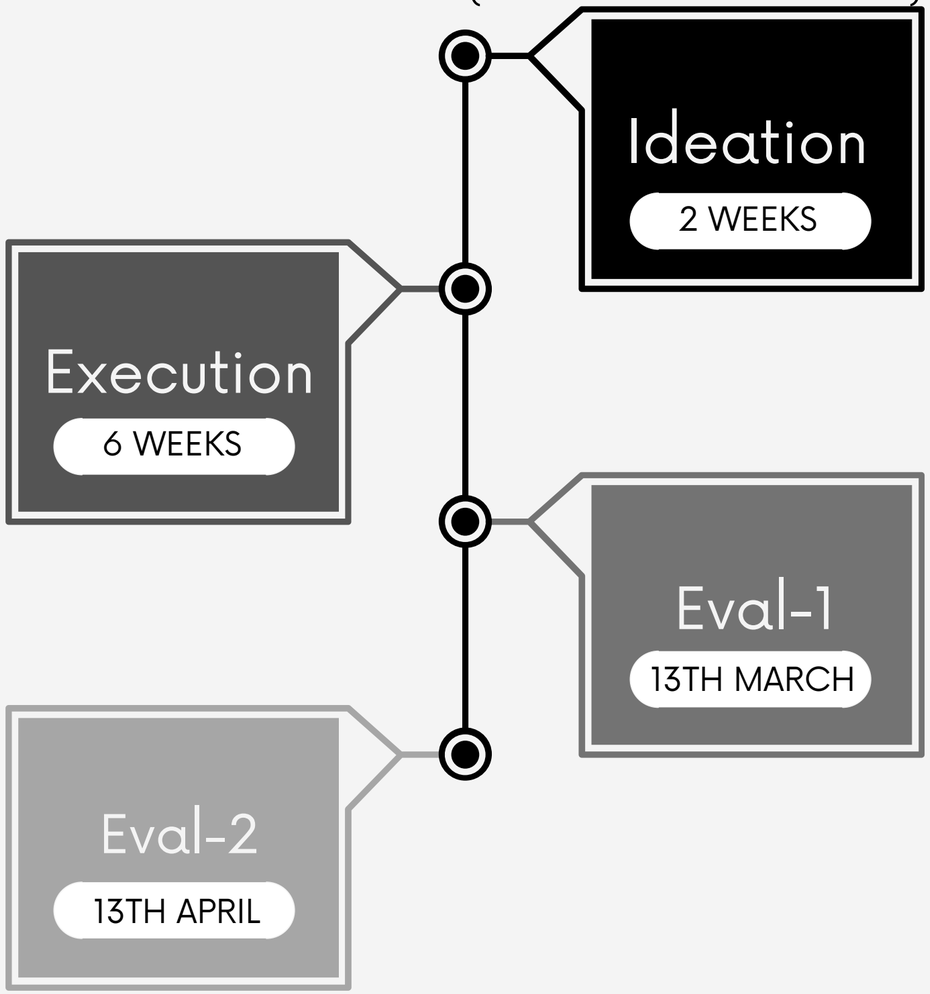
Theoretical value = 9.8m/s²

Computed value = 9.15m/s²

TIMELINE

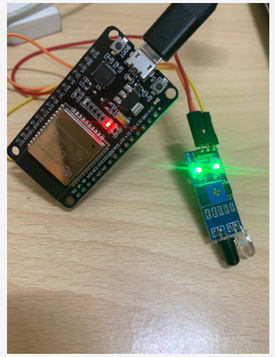
TIMELINE

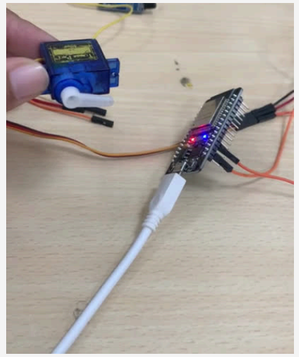
START DATE: 6TH MARCH (PROJECT ALLOTMENT)

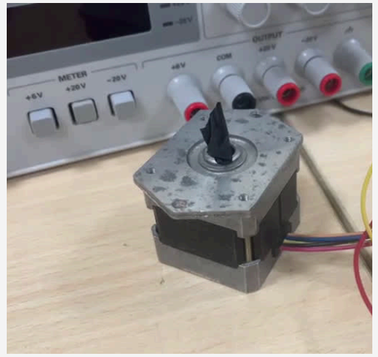


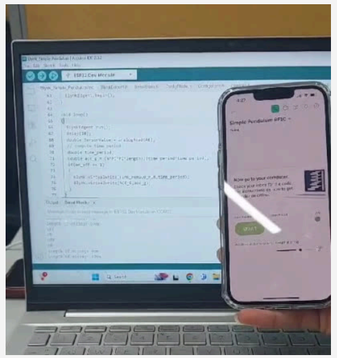
END DATE: 8TH MAY (EVALUATION)

TESTING

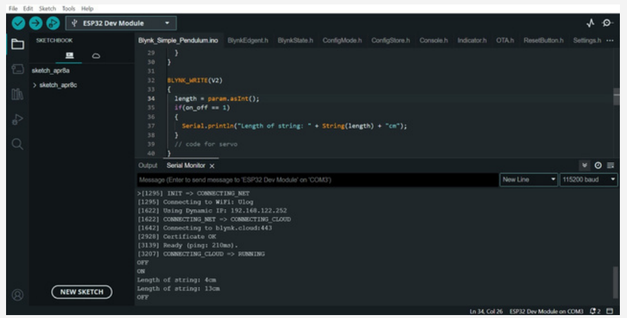




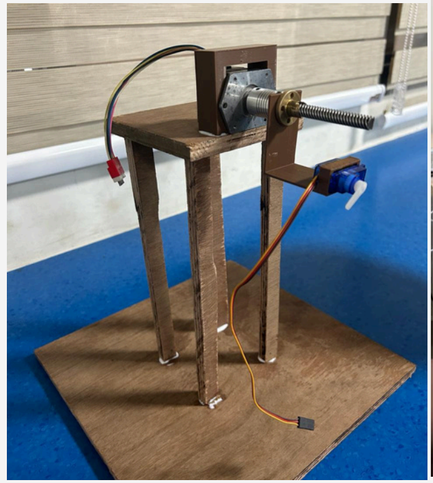


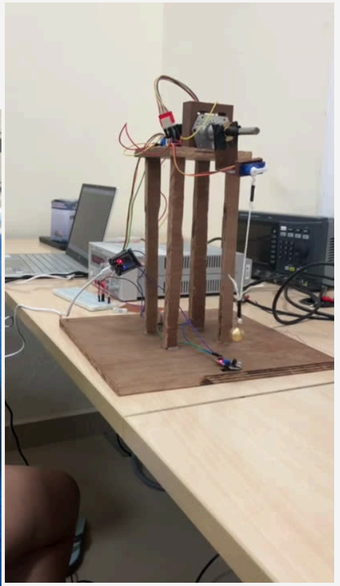


BLYNK INTEGRATION

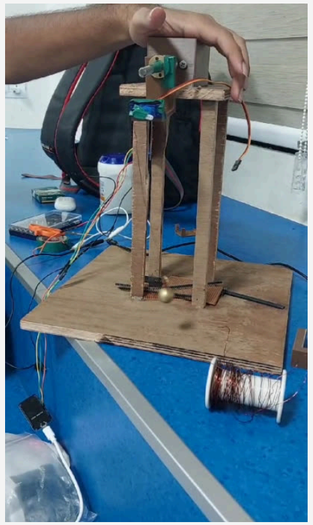


SETUP WITH STEPPER CHECKPOINT 1

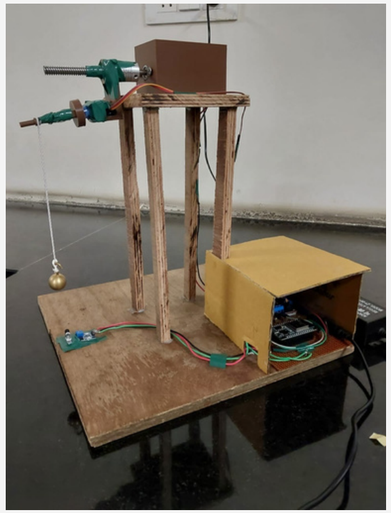


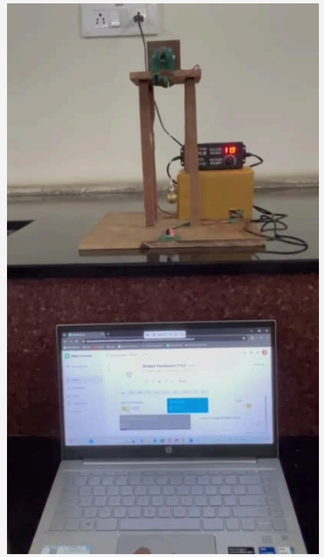


SHIFTING TO DC MOTOR



FINAL SETUP





CHALLENGES FACED

CHALLENGES

The first biggest challenge was ideation. Conceiving an idea for initiating the swing, changing the length, and measuring the time period all while trying to pack them into a neat and feasible setup took up a considerable amount of our time.

We came up with 6 design ideas, finally settling upon the presented design after carefully weighing the pros and cons of every idea and eliminating them based on their demerits.

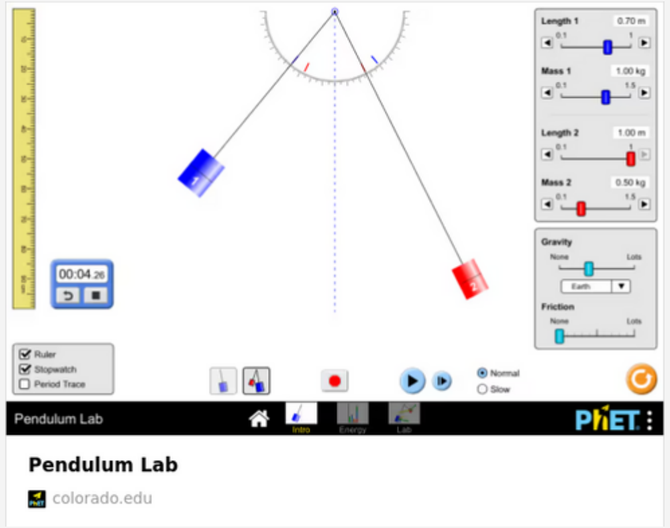
CHALLENGES

Initiating the swing came with its own challenges. Having initially decided to use a stepper motor, we realised that it consumed a lot of power and required very precise control. Ultimately, we choose a DC motor. The DC Motor had to be painstakingly calibrated to achieve the intended motion.

To change the length of the string, we wanted to use a 360 degree continuous micro-servo motor. The continuous servos in the lab were bigger than our intended design idea. We still tried to use them, but they didn't work with our code. We tried different servo motors, laptops and ESP32s in vain. In our final design we have used a 180 degree servo motor instead.

REFERENCES

- https://github.com/ShebinJoseJacob/AutomatedSimplePendulum
- A pendulum actuator for environmental vibration isolation based on magnetostrictive composite material - ScienceDirect
- https://underactuated.mit.edu/pend.html
- https://youtu.be/d--QqFK3714?feature=shared



THANK YOU