

Phys 20AL Week 3: Pendulum Improvement

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1 Aim for Experiment

The experiment is to measure the amplitude dependence of the pendulum's period, experimenting with how the maximum initial angle affects the period of the pendulum. It also aims for testing the accuracy of the provided formula, where with maximum angle θ_0 , the period formula is given as follow:

$$T(\theta_0) = 2\pi \sqrt{\frac{l}{g}} \left(1 + \frac{1}{16} \theta_0^2 + \frac{11}{3072} \theta_0^4 + \dots \right)$$

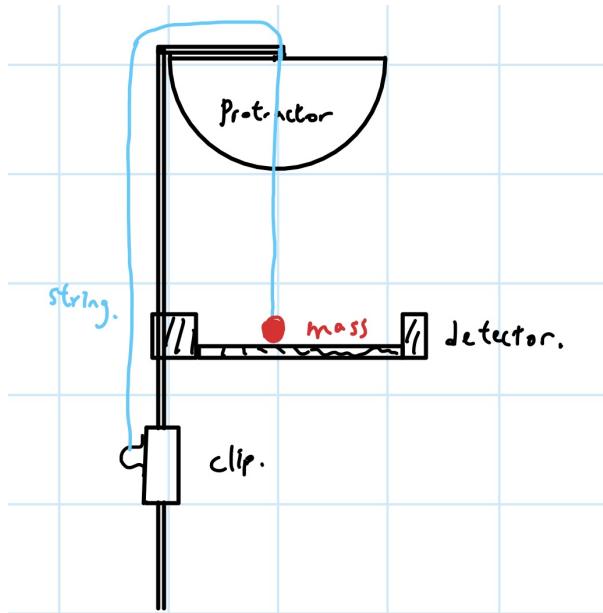
2 Experimental Setup

2.1 Experiment with Electronic Detector

Equipments include: Stand, Clamp, string, spherical mass, protractor, meter stick , detector, computer.

The following is the steps for setup:

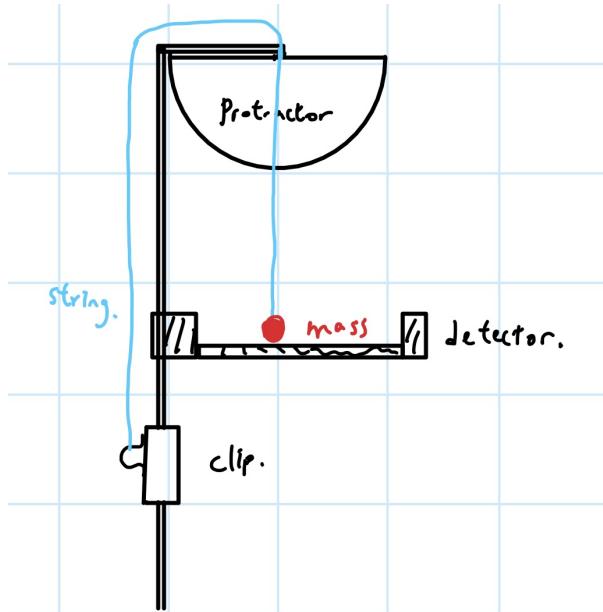
1. Setup the stand at hte edge of the table.
2. Tie one end of the string onto the clamp, pass the other end through the hole at the top of the stand, and clip the clamp onto the stand (to fix the length of the string as pendulum's arm).
3. Fix the center of the protractor at the top of the stand at where the pivot of the pendulum is at.
4. Fix the spherical mass at the free end of the string (treated as mass of the simple pendulum).
5. Fix the detector at the bottom of the stand (the location slightly lower than the spherical mass's position) for ease to detect the period of the spherical mass.



2.2 Experimnt without Electronic Detector

Equipments include: Stand, Clamp, string, spherical mass, protractor, meter stick , timer, phone (use as camera).

The setup is nearly identical with the previous one, except for not fixing a detector on the stand.



3 Measurement & Method of Measure

For each fixed manipulated variable we'll measure total of 5 trials.

For both experiment, the manipulated variables are the maximum angle of the pendulum (recorded in degrees $^\circ$, and measured using protractor). In both experiments we experimented with angle $\theta =$

$10^\circ, 20^\circ, 30^\circ, 40^\circ$, and 50° .

The responding variable on the other hand is the time period of the pendulum under the given angle. In the two setups, the measurements are done differently:

- For the setup with detector, the detector records the time when the pendulum passes through the lowest point, which serves as a recording of time period.
- For the setup without detector, it's setting up the timer in the background environment of the pendulum (let it run before starting the pendulum), and use the phone camera to record the whole pendulum process. Afterward, we'll check individual frames to get a more precise measurement of the time period (which would be a lot more tedious, so it's not possible to include the data in this lab note).

4 Collected Data (Setup with Detector only)

Rmk: The other setup records time with video, which is a lot more time consuming to check and record the actual time period, which we'll not include here (since there's no time to finish it before the lab note is due).

Trial 1		Trial 2		Trial 3		
1	Length: 65.5 cm	angle: 10				
2						
3						
4	426.177	0.058831	450.2242	0.057667	472.8955	0.056954
5	426.983	0.058134	451.0066	0.057148	473.7055	0.05629
6	427.8191	0.059343	451.8589	0.057171	474.5314	0.055245
7	429.4115	0.059749	452.0553	0.057498	476.3352	0.054917
8	429.4463	0.059508	451.4935	0.058495	476.1659	0.055621
9	430.2521	0.05924	454.2999	0.057778	476.9727	0.055098
10	431.0809	0.059842	455.128	0.059078	477.8004	0.056
11	431.8865	0.059731	455.9343	0.058222	478.6072	0.05541
12	432.7155	0.060147	456.7625	0.059582	479.4349	0.056509
13	433.521	0.059946	457.5688	0.058485	480.2416	0.055751
14	434.3502	0.06076	458.397	0.060031	481.0698	0.057009
15	435.1555	0.060285	459.2033	0.05877	481.8761	0.056244
16	435.9846	0.061193	460.0315	0.060549	482.7042	0.057405
17	436.789	0.061548	460.8376	0.059339	483.5108	0.056823
18	437.619	0.061796	461.6659	0.061115	484.3387	0.057696
19	438.4244	0.060975	462.472	0.059893	485.1449	0.057211
20	439.2355	0.062158	463.3004	0.061368	485.9732	0.056039
21	440.0587	0.06139	464.1065	0.060389	486.7798	0.05749
22	440.888	0.06253	464.9348	0.061826	487.6078	0.058507
23	441.6931	0.0619	465.7408	0.060936	488.4139	0.057629
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Figure 1: Data for angle 10°

Figure 2: Data for angle 20°

Figure 3: Data for angle 30°

Figure 4: Data for angle 40°

Figure 5: Data for angle 50°

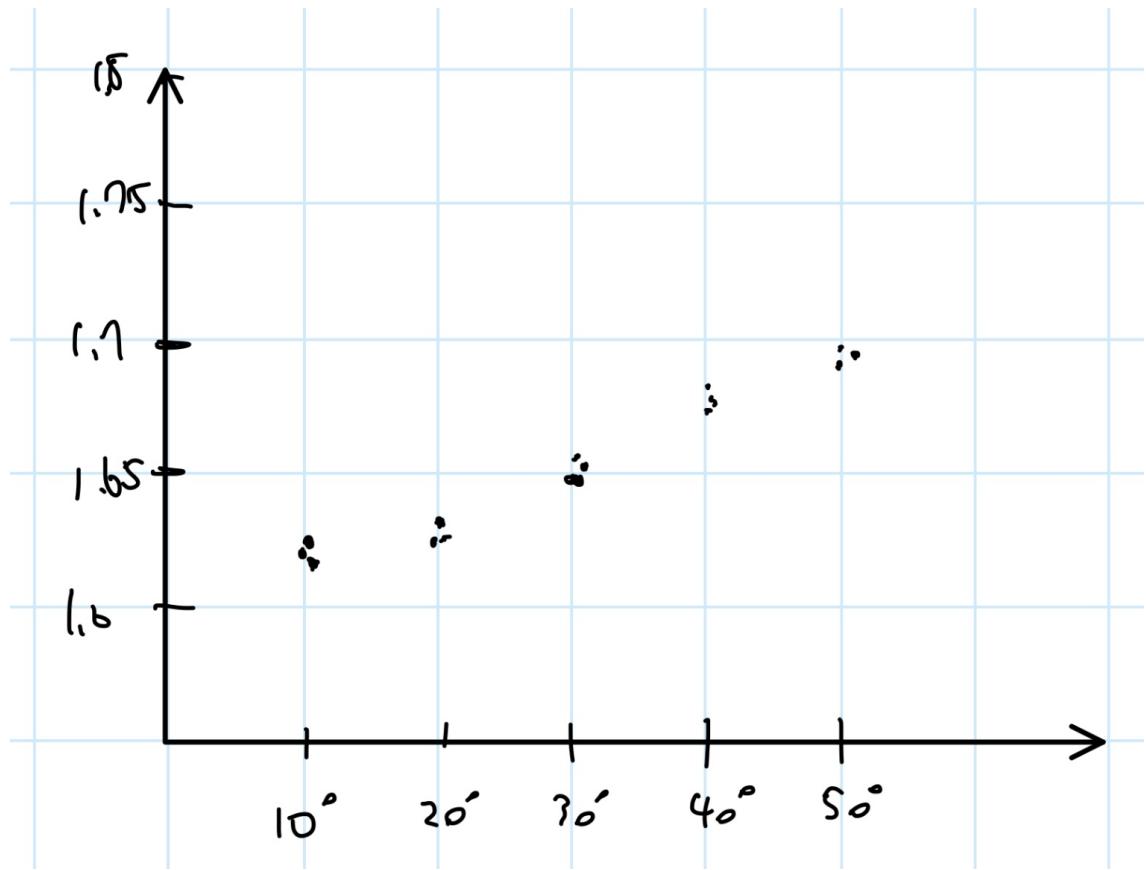


Figure 6: Sketch of the Data Table collecting the Average Time Period, with respect to Max Angle of the Pendulum