

Appendix X. Sample Lab Notebook pages

revised October 24, 2003

The following pages contain laboratory notebook pages from an experiment with a simple pendulum to determine the acceleration due to gravity.

Name: Daniel B Schultz

Date: 21 Oct 03

05

Experiment: Simple Pendulum

Partner: None

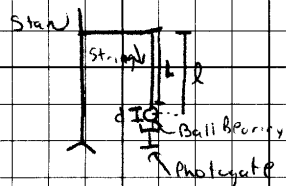
Course: PHYS 121

Section: 09A

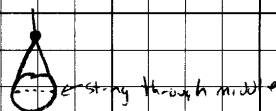
Lab Station: 20

TA: None

Apparatus:



Side view of ball-bearing



Calibration of photogate timer:

Started Logger Pro, hit "collect," blocked gate, blocked gate
and started stopwatch, blocked gate and stopped stopwatch
Stopwatch timing: 29 min 08 s to 1 sec Logger pro timing 1757.088

Used callipers to measure diameter of ball bearing. Limiting
factor: resolution of callipers

$$d = (2.58 \pm 0.01) \text{ cm}$$

Procedure:

Measure L w/ Z-meter stick

(Take off stand, tape ends so that top notch is at 10-cm mark,
pull tight, measure other end, subtract 10 cm.)

Start pendulum swinging

Start Logger Pro recording data

Let swing for 20-25 swings

Stop Logger Pro

Save Data

Shorten string

Repeat

→ Actually easier to measure L after doing run w/ Logger Pro

δL : Resolution of stick + stretching + straight + shift of knots
⇒ $\delta L \approx 2 \text{ mm}$

(T seems to decrease as time goes on; use small amplitude oscillations)

Important: Place card under blue copy.

Name: Daniel B. Schuller

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06

Experiment: Simple pendulum

All Logger-Pro files will be saved to
L:\SimplePendulum\name.mbl

L(m)	File Name	T(s)	σ (s)	N	δT (s)
(0.002 m)					
1.128	Run 01	2.14254	3.386×10^{-4}	21	0.00007
1.067	Run 02	2.08401	3.192×10^{-4}	20	0.00007
0.986	Run 03	2.00979	2.709×10^{-4}	25	0.00005
0.912	Run 04	1.92741	2.761×10^{-4}	25	0.00005
0.835	Run 05	1.84822	4.870×10^{-4}	36	0.00008
0.769	Run 06	1.77468	3.068×10^{-4}	25	0.00006
0.688	Run 07	1.67733	3.703×10^{-4}	25	0.00007
0.620	Run 08	1.58358	1.823×10^{-4}	19	0.00004
0.548	Run 09	1.41666	9.466×10^{-4}	25	0.00019
0.477	Run 10	1.39619	3.914×10^{-4}	25	0.00008
0.477	Run 11	1.37302	8.031×10^{-4}	25	0.00017
0.403	Run 12	1.29207	8.513×10^{-4}	25	0.00017
0.335	Run 13	1.17055	0.00327	21	0.0007
0.262	Run 14	1.04757	6.898×10^{-4}	24	0.00014

Measured mass of bearing w/ balance. Resolution of balance limiting factor
 $m = (23.7 \pm 0.1)g$

Note: Runs 8, 13, 14, last few oscillations didn't properly pass through photogates, have $T \sim 2 \times$ others and excluded from analysis.

$$\delta T = \sigma / \sqrt{N}$$

$$T_{\text{actual}} = T_{\text{measured}} \left(\frac{t_{\text{stopwatch}}}{t_{\text{calibration}}} \right) = T_{\text{measured}} \left(\frac{17.499}{17.57088} \right)$$

$$\delta T_{\text{actual}} = T_{\text{actual}} \sqrt{\left(\frac{\delta T}{T_{\text{meas}}} \right)^2 + \left(\frac{\delta t_{\text{stop}}}{t_{\text{stop}}} \right)^2}$$

Do these calculations in Origin

Use Run 05 for "typical" run histogram
Histogram saved as L:\SimplePendulum\Hist.005

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Name: Panipat Schultz Date: 21 Oct 03

07

Experiment: Simple Pendulum

~~Plot~~ From Theory: $T = 2\pi\sqrt{\frac{L}{g}}$

$$\Rightarrow \left(\begin{matrix} L \\ y \end{matrix} \right) = \left(\begin{matrix} \frac{g}{4\pi^2} T^2 \\ m \end{matrix} \right) \left(\begin{matrix} x \\ x \end{matrix} \right) + b$$

$$\Rightarrow g = 4\pi^2 m$$

$$\delta g = 4\pi^2 \delta m$$

$$L = L + \frac{L}{2}$$

$$\delta L_2 \ll \delta L_1 \Rightarrow \delta L \approx \delta L_1$$

$$\delta_{T^2} = \left| \frac{\partial}{\partial T} T^2 \right| \delta T = 2T \delta T$$

Save Origin file as L:\Simple Pendulum\Results.opj

$$\text{Slope} = (0.2485 \pm 0.0005) \text{ m/s}^2$$

$$\Rightarrow g = 4\pi^2 (0.2485) = 9.81039$$

$$\delta g = 4\pi^2 (0.0005) = 0.02$$

$$\Rightarrow \boxed{g = (9.81 \pm 0.02) \text{ m/s}^2}$$

Conclusions

Good agreement w/ accepted value ($\approx 9.8 \text{ m/s}^2$)

Poss. sources of systematic error:

Air Drag

Small angle approximation

Rel. uncertainty $\approx 0.2\%$, not bad

Hard to get > 3 sig. figs on g

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