Appendix XII. Sample Lab Notebook pages

revised October 24, 2003

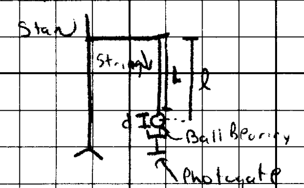
The following pages contain laboratory notebook pages from an experiment with a simple pendulum to determine the acceleration due to gravity.

Name: Daniel B Schultz   Date: 21 Oct 03   05

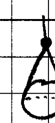
Experiment: Simple Pendulum   Partner: None

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 [illegible] ±0.1 sec   Logger pro timing 1757.088

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

$$d = (2.58 \pm 0.01)\,cm$$

Procedure:

Measure L w/ 2-meter stick
(Take off stand, tape ends so that top notch is at 10-cm mark, pull tight, measure other end, subtract 10cm.)
Start pendulum swinging
Start Logger Pro recording data
Let swing for 20-25 swings
Stop Logger Pro
Save Data → Actually easier to measure L after doing run w/ Logger Pro
Shorten string
Repeat

δL: Resolution of stick + stretching straight + shift of knots
$\Rightarrow \delta L \approx 2mm$

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

Important: Place card under blue copy.

Name: Daniel B Schultz *Date:* 21 Oct 03

Experiment: Simple pendulum

All LoggerPro files will be saved to
L:\SimplePendulum\name.mbl

L (m) (±0.002 m)	File Name	T (s)	σ (s)	N	δT (s)
1.128	RunØ1	2.14254	3.386×10^{-4}	21	0.00007
1.067	RunØ2	2.08401	3.192×10^{-4}	20	0.00007
0.986	RunØ3	2.00979	2.709×10^{-4}	25	0.00005
0.912	RunØ4	1.92741	2.761×10^{-4}	25	0.00005
0.835	RunØ5	1.84822	4.890×10^{-4}	36	0.00008
0.769	RunØ6	1.77068	3.068×10^{-4}	25	0.00006
0.688	RunØ7	1.67733	3.703×10^{4}	25	0.00007
0.620	RunØ8	1.58558	1.823×10^{4}	19	0.00004
0.548	RunØ9	1.41666	9.466×10^{4}	25	0.00019
0.477	Run1Ø	1.39619	3.914×10^{-4}	25	0.00008
0.477	Run11	1.39302	8.631×10^{-4}	25	0.00017
0.403	Run12	1.29207	8.513×10^{-4}	25	0.00017
0.335	Run13	1.17085	0.00327	21	0.0007
0.262	Run14	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 ~ 2x others and excluded from analysis.

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

$$T_{actual} = T_{measured}\left(\frac{t_{stopwatch}}{t_{calibration}}\right) = T_{measured}\left(\frac{\cancel{1754.9s}\ 1749.9}{1757.0884}\right)$$

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

Do these calculations in Origin

Use RunØ5 for "typical" run histogram
Histogram saved as L:\SimplePendulum\Hist.OPJ

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Name: Daniel B Schultz Date: 21 Oct 03 07

Experiment: Simple Pendulum

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

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

$y = m x + b$

$\Rightarrow g = 4\pi^2 m \qquad \delta_g = 4\pi^2 \delta_m$

$l = L + \frac{d}{2} \qquad \delta_{d/2} \ll \delta_L \Rightarrow \delta_l \approx \delta_L$

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

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

Slope $= (0.2485 \pm 0.0005)\, m/s^2$

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

$\delta_g = 4\pi^2(0.0005) = 0.02$

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

Conclusions

Good agreement w/ accepted value ($\sim 9.8\, m/s^2$)

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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