Simple measurements & free fall

Identification page

Instructions: Print this page and the following ones before your lab session to prepare your lab report. Staple them together with your graphs at the end. If you forgot to print it before your lab, you can reproduce it by hand but you have to follow the exact format (same number of pages, same items on each page, same space to answer question).

Complete all the identification fields below or 10% of the lab value will be deduced from your final mark for this lab.

For in-lab reports, hand in your report to your demonstrator at the end of the sessions or you will receive a zero for this lab.

For take-home reports, drop your report in the right box or 10% of the lab value will be deduced from your mark. Refer to the *General information* document for the details of the late report policy.

Experiment title: Simple measurements & free fall

Name: _____

Student number: _____

Lab group number: _____

Course code: PHY

Demonstrator: _____

Date of the lab session: _____

Partner's name: _____

Data sheet

Instructions: Use a pen to complete this section before the end of the lab session. Ask your TA to initialize your data before you leave the laboratory.

Part 1 – Length measurement

[1] **Table 1 – Mass measurements of various objects**

Object	Mass	
	m	Δm
	(g)	(g)
Rectangular prism		
Hollow cylinder		

[3] **Table 2 - Length measurements of a rectangular prism using various instruments**

Instrument	Length of short side		Length of medium side		Length of long side	
	a	Δa	b	Δb	c	Δc
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
meter stick						
vernier caliper						

[1] **Table 3 - Length measurements of a hollow cylinder using a vernier caliper**

Instrument	Length		Outer diameter		Inner diameter	
	l	Δl	D	ΔD	d	Δd
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
vernier caliper						

Part 2 – Time measurement

[1] **Table 4 - Calculating the period of oscillation of a mass-spring system**

Trial	Time for 10 oscillations	
	t	Δt
	(s)	(s)
1		
2		
3		
4		
5		

Part 3 – Picket fence free fall

[4] Prepare Graph 1. Print it to a pdf file. Send the file to yourself by email or save it on a USB key. Print the graph and attach it at the end of your report.

[2] **Table 5 - Linear regression results for the free falling picket fence experiment**

Trial	Slope		y-intercept	
	m	Δm	b	Δb
1				
2				
3				
4				
5				

Questions

Instructions: You can finish this section at home. We encourage you to start answering these questions while you are still in the lab and the TA is available to help you.

Part 1 – Length measurement

[2] Calculate the volume V of the rectangular prism (in mm^3) using the vernier caliper data (including the error calculation). Refer to the tutorial *How to present a calculation example* to know how to present such calculations.

[2] Calculate the density ρ (in kg/m^3) of the rectangular prism using the caliper data (including the error calculation).

[2] Calculate the volume V (in mm^3) of the hollow cylinder (including the error calculation).

[2] Calculate the density ρ (in kg/m^3) of the hollow cylinder (including the error calculation).

[4] Prepare a table for your volume and density measurements of both objects. You have to present the volumes and densities for the rectangular prism calculated using the two instruments and the one you calculated for the hollow cylinder (including uncertainties). Refer to the tutorial *How to prepare a table* to know how to prepare a table for the physics labs. Your table should contain columns for the objects, the measuring instruments, the volumes (in mm^3) and the densities (in kg/m^3).

[1] Having evaluated the error associated with the density of the rectangular prism using the meter stick and the Vernier caliper, which instrument gives the smallest calculated error for density? Why?

[2] Compare your most precise density for the rectangular prism with the accepted values of various substances listed below and determine which type of metal it is made of.

You can use a percentage difference calculation to compare: $\%\text{diff} = \left|\frac{\rho_{\text{accepted}} - \rho_{\text{experimental}}}{\rho_{\text{accepted}}}\right| \times 100$.

Densities of common substances

Material	Density, ρ $(kg/m^3)\times10^3$
Aluminum	2.7
Benzene	0.90
Blood	1.06
Brass	8.6
Concrete	2
Copper	8.9
Ethanol	0.81
Glycerin	1.26
Gold	19.3
Ice	0.92
Iron	7.8
Lead	11.3
Mercury	13.6
Platinum	21.4
Seawater	1.03
Silver	10.5
Steel	7.8

[2] Compare your density for the hollow cylinder with the accepted values of various metals listed above and determine which type of metal it is made of. Calculate the percentage difference.

Part 2 – Time measurement

[2] Using the data from your *Table 4*, fill the following table:

Table 6 - Calculating the period of oscillation of a mass-spring system

Trial	Period	
	T	ΔT
	(s)	(s)
1		
2		
3		
4		
5		

[2] Using your values for T, calculate the average period $\bar{T}$ and its standard error.

[2] How does the error on the average period $\bar{T}$ compares to the errors on the periods, T? What can you do to reduce the uncertainty on $\bar{T}$? What can you do to reduce the uncertainty on T?

Part 3 – Picket fence free fall

[1] How does the Logger Pro software calculate the speed of the picket fence?

[1] Discuss what the slope and y-intercept represent in terms of the experimental parameters.

[1] Predict whether the slope and/or the y-intercept would change if you were to drop the picket fence through the photogate starting from a higher point.

[2] Using your five fit results, calculate your average value for the gravitational acceleration, $\bar{g}$, and its standard error.

[1] Compare your value of $\bar{g}$ with the accepted value of 9.81 m/s^2. Use the percentage difference calculation:

$$\%\text{diff} = \left|\frac{g_{\text{acceted}} - \bar{g}}{g_{\text{accepted}}}\right| \times 100,$$

and discuss.

Total : _____ / 41