Simple measurements & buoyancy force

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 & buoyancy force

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] Measure the mass of the cylinder:

$M_{\text{cylinder}} = (\_\_\_\_\_ \pm \_\_\_\_\_)$

[3] **Table 1 - Length measurements of a cylinder using various instruments**

Instrument	Length of the cylinder		Diameter of the cylinder	
	L	ΔL	D	ΔD
	(mm)	(mm)	(mm)	(mm)
meter stick				
vernier caliper				

Part 2 – Time measurement

[1] **Table 2 - Calculating the period of oscillation of a pendulum**

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

Part 3 – The buoyancy force

[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.

[1] What are the values of m (slope) and b (Y-intercept) in Graph 1? Provide the units.

$m = (\_\_\_\_\_ \pm \_\_\_\_\_)$ $\quad$ $b = (\_\_\_\_\_ \pm \_\_\_\_\_)$

[1] What is the apparent mass value you recorded with the setup using an electronic balance and a 500 g mass suspended in water?

$m_{\text{apparent}} = (\_\_\_\_\_ \pm \_\_\_\_\_)$

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 cylinder (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 cylinder using the vernier caliper data (including the error calculation).

[4] Prepare a table for your volume and density measurements. You have to present the volumes and densities for the cylinder calculated using the two instruments. 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 measuring instruments, the volumes (in mm^3) and the densities (in kg/m^3). Don't forget to include uncertainties!

[1] Having evaluated the error associated with the density of the cylinder using different instruments, which instrument has the smallest error? Why?

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

Calculate the percentage difference: $\%\text{diff} = \left|\frac{\rho_{\text{accepted}} - \rho_{\text{experimental}}}{\rho_{\text{accepted}}}\right| \times 100$.

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

Part 2 – Time measurement

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

Table 3 - Calculating the period of oscillation of a pendulum

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 T? What can you do to reduce the uncertainty on $\bar{T}$? What can you do to reduce the uncertainty on T?

Part 3 – The buoyancy force

[3] Using your fit results, calculate the density of water in kg/m^3 and its uncertainty (use $g = 9.81$ m/s^2).

[2] The density of olive oil is around 920 kg/m^3. What would change in your Graph 1 if the water was replaced with olive oil?

[2] For the setup with the balance, explain why you are reading a mass on the balance even though the object is suspended and not touching the bottom of the beaker?

[3] Calculate the volume of the suspended mass and its uncertainty. Use $\rho_{\text{water}} = 997.77$ kg/m^3 (at 22°C).

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