Standing waves in a string

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: Standing waves in a string

Name: _____

Student number: _____

Lab group number: _____

Course code: PHY

Demonstrator: _____

Date of the lab session: _____

Partner's name: _____

Data sheet

Instructions: This lab report is due at the end of the lab session. We recommend completing the *Data sheet* before starting the *Questions* section.

Preliminary manipulations and calculations

[1] Measure the length L in meters and **estimate** the uncertainty:

$L = (\_\_\_\_\_ \pm \_\_\_\_\_)$

[2] Measure the mass (in kg) and the length (in m) of the sample string (**estimate** the uncertainty for the length):

$l = (\_\_\_\_\_ \pm \_\_\_\_\_)$

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

[2] Calculate the linear density of the string (and its uncertainty) in kg/m.

[2] Using equations 1, 2 and 3, derive the formula to calculate the frequency as a function of the mode number n, the string length L, the tension T and the string linear density μ.

[1] Use your formula to predict the fundamental frequency for modes $n = 2$ and a suspended mass of 350g. No need for error calculations.

[4] Fill the second and fourth columns of the following table:

Table 1 - Fundamental frequencies as a function of the tension in the string

Hanging mass description	Total hanging mass (hanger + masses), m (kg)	Mode number, n	Calculated frequency, f_{cal} (s^{-1})	Measured frequency, f_{exp} (s^{-1})
Hanger + ≈ 0.1 kg	±	2		±
		3		±
		4		±
		5		±
Hanger + ≈ 0.2 kg	±	2		±
		3		±
		4		±
		5		±
Hanger + ≈ 0.3 kg	±	2		±
		3		±
		4		±
		5		±

Part 1 - Wavelength and frequency

[2] Try touching the string at an anti-node. What happens? Try touching the string at the central node. Can you hold the string at the node and not significantly affect the vibration?

[2] While the string is still vibrating for $n = 2$, remove 100 g from the mass hanger. Describe and explain what happens then.

Part 2 - Wave speed and string density

[2] Fill the last column of *Table 1*.

[1] Explain how you can prepare a graph for which the slope will be the linear density, μ, of the string using data from *Table 1*.

[4] Prepare Graph 1. Submit it online before the end of the lab session.

[1] What is the value of the slope in Graph 1? Provide the units.

$\text{slope} = \mu_{\text{experimental}} = (\_\_\_\_\_ \pm \_\_\_\_\_)$

Questions

Part 2 - Wave speed and string density

[2] Compare your experimental value for the string density with the calculated (theoretical) one. Calculate the percentage difference

$$\%\text{diff} = \left|\frac{\mu_{\text{calculated}} - \mu_{\text{experimental}}}{\mu_{\text{calculated}}}\right| \times 100,$$

and discuss.

[2] What would happen to your results (graph and calculation of μ) if the string was elastic?

[2] Explain why the strings of lower tones on a guitar are thicker. Explain why notes of higher pitch are produced when the fingers are placed on the strings.

Total : _____ / 30 (for the report and graph)