☐PHYS115 ☑PHYS121 ☐PHYS123
☐PHYS116 ☐PHYS122 ☐PHYS124
Lab Cover Letter

Author (*You*) Trevor Swan Signature: Trevor Swan

I declare that this assignment is original and has not been submitted for assessment elsewhere, and acknowledge that the assessor of this assignment may, for the purpose of assessing this assignment: (1) reproduce this assignment and provide a copy to another member of faculty; and/or (2) communicate a copy of this assignment to a plagiarism checking service (which may then retain a copy of this assignment on its database for the purpose of future plagiarism checking).

Lab Partner(s) Adi Mallik

Date Performed 4/17/24 Date Submitted 4/17/24

Lab (*such as #1: UNC*) #7: SND_VEL/STWAVE

TA: Philip Dudones

GRADE (*to be filled in by your TA*) See your TA for detailed feedback.
An '*x*' next to a subcategory means you need to improve this aspect of your work.

***Paper Subtotals* (points)**

( ) ***General* (6)**
_____ Sig. figs.
_____ Units
_____ Clarity of Presentation
_____ Format

( ) ***Abstract* (4)**
_____ Quantity or principle
_____ How measurement was made
_____ Numerical Results
_____ Conclusion

( ) ***Intro & Theory* (9)**
_____ Basic principle
_____ Main equations to be used
_____ Apparatus
_____ What will be plotted
_____ Fitting parameters related

( ) ***Exp. Procedures* (15)**
_____ Description
_____ Stating and justifying uncertainties
_____ Data Record
_____ Quality of Lab Work

( ) ***Analysis & Error Analysis* (20)**
_____ Discussion
_____ Equations & Calculations
_____ Presentation inc. Graphs, Tables
_____ Results Reported & Reasonable
_____ Underlined items addressed

( ) ***Discussion & Conclusions* (6)**
_____ Numerical comparison of results
_____ Logical conclusions
_____ Discussion of pos. errors
_____ Suggestions to reduce errors

( ) **Paper Total (60 points)**
(30 points for CME or EPF)

( ) **Notebook (10 points)**
_____ Format (*proper style, following directions*)
_____ Apparatus (*brief description of equipment, including sketches*)
_____ Data (*including computer file names and manually recorded data*)
_____ Experimental Technique (*describing your procedures; stating & justifying uncerts.*)
_____ Analysis (*results and errors*)

( ) **Worksheet(s)/Fill-in-the-Blank-Report (30 points)** *if applicable*

( ) **Adjustments** – late submissions, improper procedures, etc. – or bonus points for exceptional work.

( ) Total Grade

Graded by ___________ *(TA's initial)*

Sound Velocity Worksheet

Your Name: Trevor Swan **Signature:** [signature]

Lab partner(s): Adi Mallik

Course & Section: PHYS121-112B **Station #** B **Date:** 4/17/24

Distance d with uncertainty and units: $\boldsymbol{d}$ = 1.5122 ± 0.0001 m

What is the uncertainty in your measurements of time? ± 0.0003

Trial	Time	Velocity $v = \frac{2L}{\Delta t}$
1	0.0087s	347.63 m/s
2	0.0087s	347.63 m/s
3	0.0083 s	364.39 m/s
4	0.01004s	301.24 m/s
5	0.00926s	326.61 m/s
6	0.00904s	334.56 m/s
7	0.00868s	348.43 m/s
8	0.0086s	351.67 m/s
9	0.00936	323.12 m/s
10	0.00672	346.8 m/s

Mean velocity = 339.21 m/s Standard dev. = 18.12 m/s St.error of mean = 5.73 m/s

Calculated uncertainty in velocity for one typical run. δ_v = 11.99 m/s
Show your work on the back of this page.

How does this uncertainty compare to your results for Standard Deviation and St. error of the mean for your multiple trials? Do your results make sense? These results do agree within their uncertainties. This uncertainty is very large because Δt was inconsistent in its measurements due to hard to read peaks.

B = 138651.43 ± 4801.79 $\frac{kg}{m s^2}$ Show your work on the back of this page.
Attach a printout of one of your *Logger Pro* plots.

GRADE:_______ **GRADED BY** ________
(out of 15 points) (TA's initials)

Show your work for the calculation of the uncertainty in velocity for one typical run and for your calculation of the bulk modulus of air and its uncertainty:

Velocity of Trial 1

$v = \frac{2l}{\Delta t}$, $\delta_l = 0.0001 m$, $\delta_{\Delta t} = 0.0003$, $l = 1.5122 m$, $\Delta t = 0.0087 s$

$$\delta_v = \sqrt{\delta_{v,l}^2 + \delta_{v,\Delta t}^2}$$

$$\delta_{v,l} = \frac{\partial}{\partial l}\left(\frac{2l}{\Delta t}\right) * \delta_l = \frac{2}{\Delta t} * \delta_l = 0.02299$$

$$\delta_{v,\Delta t} = \frac{\partial}{\partial \Delta t}\left(\frac{2l}{\Delta t}\right) * \delta_{\Delta t} = \left|\frac{-2l}{\Delta t^2}\right| * \delta_{\Delta t} = 11.99$$

$$\delta_v = \sqrt{0.02299^2 + 11.99^2} = 11.99 \ m/s$$

Bulk Modulus

$v = \sqrt{\frac{B}{\rho}} \rightarrow B = \rho v^2$ $\quad \rho = 0.001205 \frac{g}{ml} \times \frac{1 kg}{1000 g} \times \frac{1 ml}{1 cm^3} \times \frac{100^3 cm^3}{1 m^3}$

$$= 1.205 \ kg/m^3$$

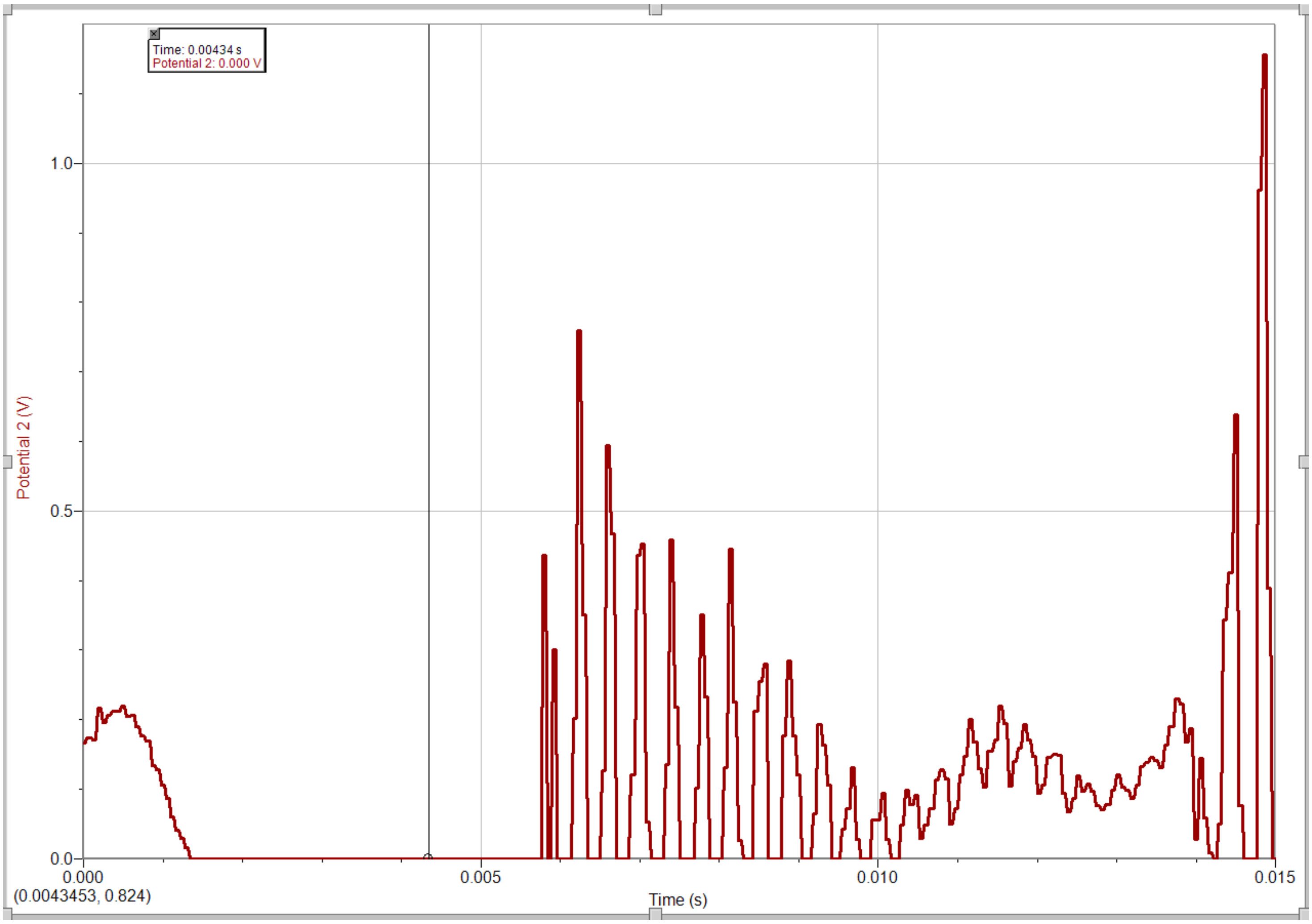
$$B = 1.205 \ kg/m^3 (339.21 \ m/s)^2$$

$$= 138651.43 \ \frac{kg}{m \cdot s^2}$$

δ_ρ is negligible because value comes from textbook, so $\delta_B = \sqrt{\delta_{B,v}^2}$

$$\delta_{B,v} = \frac{\partial}{\partial v}(\rho v^2) * \delta_v = 2\rho v * \delta_v = 9801.79$$

$$\delta_B = \sqrt{9801.79^2} = 9801.79 \ \frac{kg}{m \cdot s^2}$$


Time: 0.00434 s
Potential 2: 0.000 V
Potential 2 (V)
1.0
0.5
0.0
0.000
0.005
0.010
0.015
(0.0043453, 0.824)
Time (s)

Standing Waves on a String Worksheet

Your Name: Trevor Swan **Signature:** Trevor Swan

Lab partner(s): Adi Mallik

Course & Section: PHYS121-112B **Station #** B **Date:** 4/17/24

String mass M_{string} = 6.8 ± 0.1 g or 0.0068 ± 0.0001 kg

String length L = 143.62 ± 0.01 cm or 1.4362 ± 0.0001 m

Discussion of reasoning for appropriate length for finding μ and measurement techniques:

$$\mu = \frac{M}{l} = \frac{0.0068 \text{ kg}}{1.4362 \text{ m}} = 0.0047 \pm 0.0001 \text{ kg/m}$$

0.0001 UNC estimate based on values above!

• Mass of the string determined by placing full string on scale.

• Length determined by holding string in tension with 250g hanging mass and measuring from top to tail. We added 4 cm to account for knots and loops at ends.

Linear density μ = 0.0047 ± 0.0001 kg/m

Mass of hanging mass M_{mass}= 250 g (we can assume negligible uncertainty)

Enter into the table on the reverse side of this worksheet the frequencies, periods and wavelengths of each arrangement of standing waves that you observe. Include uncertainties.

λ vs. period

Measured velocity of wave propagation V_M = 26.5 ± 0.2 m/s

Predicted value $V_P = \sqrt{\frac{T}{\mu}}$ 22.8315 ± 0.0001 m/s

Compare your measured and predicted values of the wave velocity. Comment on their consistency. Justify your conclusions.

We had to hold the apparatus in place to prevent horizontal oscillations. This influenced our frequency values, thus our periods were off as well. This resulted in our predicted and measured velocities not agreeing within their uncertainties.

Attach a printout of your *Origin* graph and linear fit, with fit parameters.

Only measured one, so close to 1 and $\lambda = \frac{2D}{1}$

$\lambda = 2D$

Number of Loops n	Frequency f (Hz)	1/freq. Period T(s)	Length D of ~~n~~ 1 loops (m)	Wavelength λ (m)
1	10.4	0.0962	1.2795	2.559
2	20.8	0.0481	0.6048	1.2096
3	30.8	0.03247	0.4107	0.8214
4	40.8	0.02451	0.3109	0.6218
5	50.8	0.0197	0.2501	0.5002
6	60.8	0.0164	0.2092	0.4184
7	70.8	0.0141	0.1798	0.3596
8	80.8	0.0124	0.1577	0.3139
9	90.8	0.0110	0.1404	02808
10	100.8	0.0099	0.1265	0.253
11	110.8	0.0090	0.1151	0.2362
12	120.8	0.0083	0.1056	0.212
13	130.8	0.0077	0.0976	0.1952

UNC: ±0.2 ± 0.0001 ±0.0001 ±0.00001

GRADE:________
(out of 15 points)

GRADED BY ________
(TA's initials)

Trevor Swan
Adi Mallik