

Investigating stationary waves on a string

$$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

Derived from $c = f\lambda$ and $c = \sqrt{\frac{T}{\mu}}$

From <https://hyperphysics.phy-astr.gsu.edu/...hbase/Class/PhSciLab/string2.html>

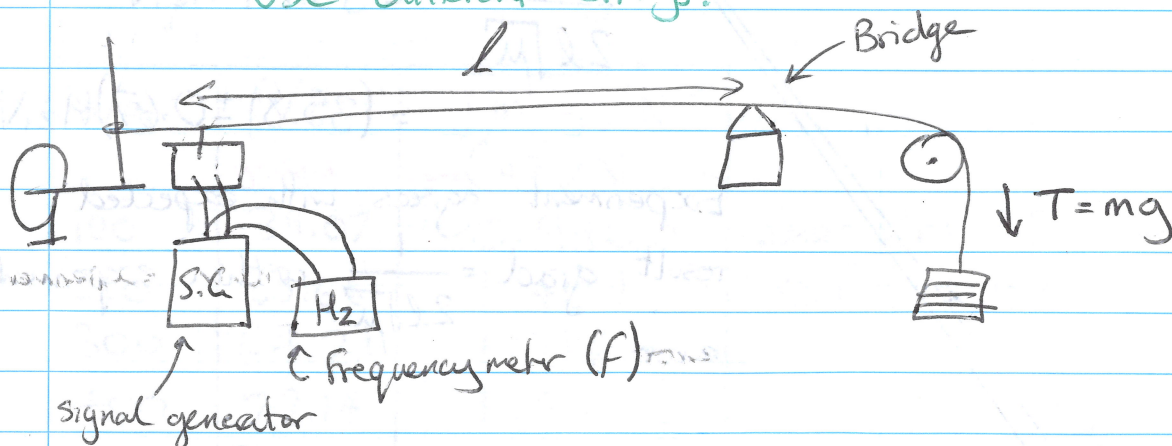
Accessed at 0720 on 19 NOVEMBER 2024

f (frequency of wave) dependent variable.

Prac 1: L (length of vibrating string) independent variable,
 T (Tension) and μ (mass per unit length) control variables.
Use string 1

Prac 2: T independent variable
 L & μ control variables
Use string 1

Prac 3: μ independent variable
 L & T control variables.
Use different strings.



To control T , keep masses suspended from pulley the same

To control L , do not move bridge

To control μ , keep same string

Prac 1

$$T = (0.300 \pm 0.006) \times 9.81 = (2.943 \pm 0.059) \text{ N}$$

$$\mu = (0.39 \pm 0.01) \text{ g} \div (2.000 \pm 0.004) \text{ m} = (0.1950 \pm 0.0054) \text{ g/m}$$

l/m y-axis	f/Hz	$(l/\text{m})^{-1}$ x-axis	
1.000	63.12 64.21	1.0000	$\Delta l = 0.005 \text{ m}$ $\Delta f = 0.01 \text{ Hz}$
0.800	79.48	1.250	
0.600	104.8	1.667	$\Delta f = 0.1 \text{ Hz}$ (changed)
0.500	125.8	2.000	
0.400	153.5	2.500	

$$f = \frac{\sqrt{T}}{2\sqrt{\mu}} \cdot \frac{1}{l} + 0$$

$$y = \text{grad} \cdot x + c$$

Prac 2

$$l = (1.000 \pm 0.005) \text{ m}$$

$$\mu = (0.39 \pm 0.01) \text{ g} \div (2.000 \pm 0.004) \text{ m} = (0.1950 \pm 0.0054) \text{ g/m}$$

m/g	f/Hz y-axis	$\sqrt{m \times g} / \text{N}^{1/2}$ x-axis ($\sqrt{T} / \text{N}^{1/2}$)	
100	39.07	0.9905	Δm $\Delta m = 2\%$ $\Delta f = 0.01 \text{ Hz}$
200	53.66	1.401	
300	64.21	1.716	
400	72.14	1.981	
500	79.94	2.215	
600	88.16	2.426	
700	95.69	2.620	

$$f = \frac{1}{2l\sqrt{\mu}} \cdot \sqrt{T} + 0$$

$$y = \text{grad} \cdot x + c$$

Prac 3

String	m/g	L/m	μ/gm^{-1}	$\Delta\mu/gm^{-1}$
String 1	0.39	2.000	0.0195 0.1950	0.0054
String 2	0.17	2.000	0.0850	0.0052
String 3	0.08	3.000	0.0267	0.0067
String 4	0.07	3.000	0.0233	0.0067
String 5	1.49	1.560	0.9551	0.0089

μ/gm^{-1}	f/Hz	
0.1950	64.21	$\Delta f = 0.01 Hz$
0.0850	98.34	
0.0267	168.2	$\Delta f = 0.1 Hz$
0.0233	179.1	
0.9551	28.38	$\Delta f = 0.01 Hz$

$$T = (2.943 \pm 0.059) N$$

$$L = (1.000 \pm 0.005) m$$

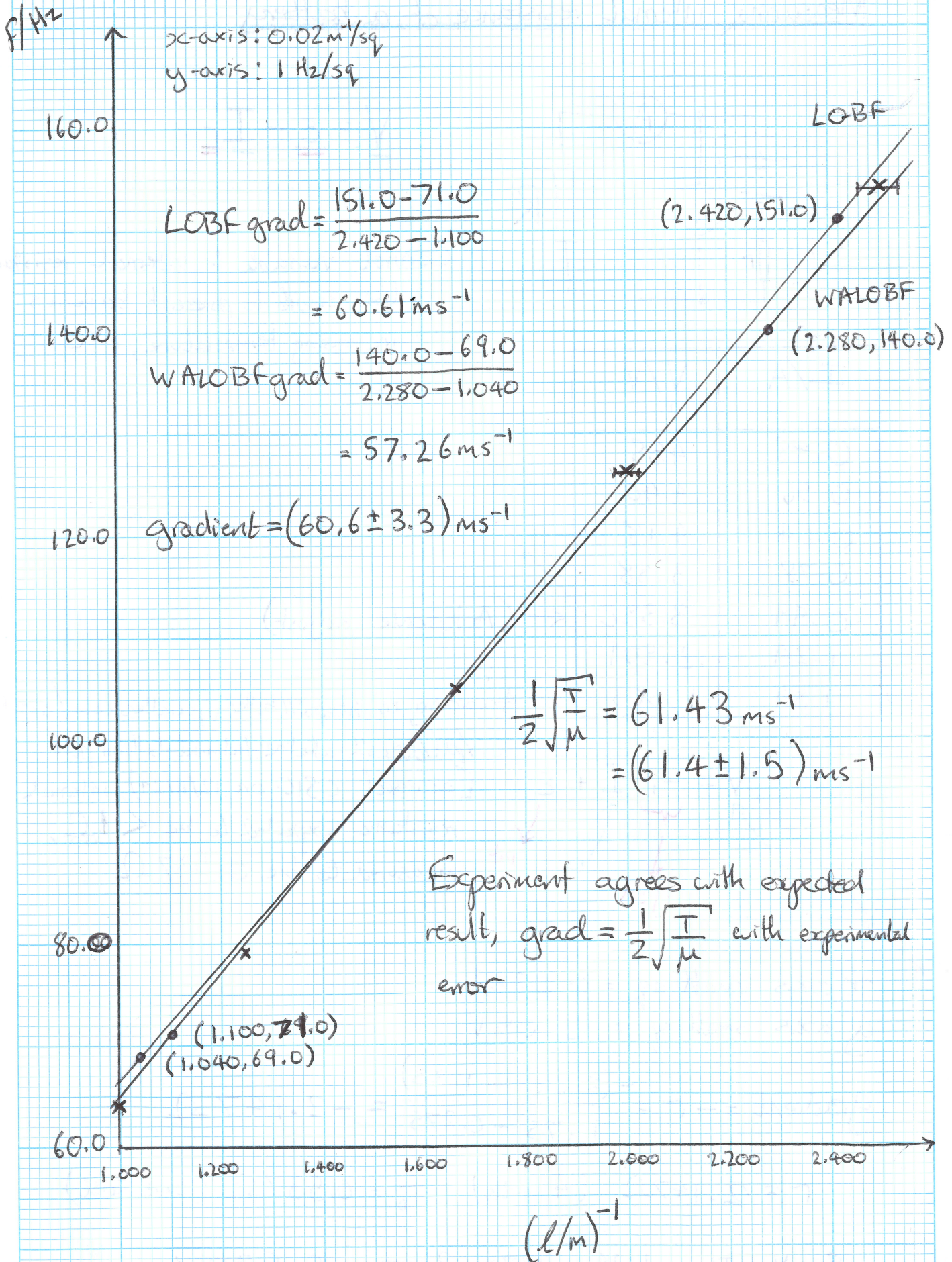
$$f = \frac{\sqrt{T}}{2L} \cdot (\mu)^{-1/2} + 0$$

$y = \text{grad } x + c$

f/Hz y-axis	$(\mu/kgm^{-1})^{-1/2}$ x-axis
64.21	71.611
98.34	108.5
168.2	193.5
179.1	207.2
28.38	32.36

For all three practicals, the expected result agreed with the measured result within experimental error.

Prac 1



f/Hz

Prac 2x-axis: $0.02 \text{ N}^{1/2}/\text{sq}$ y-axis: $0.5 \text{ Hz}/\text{sq}$

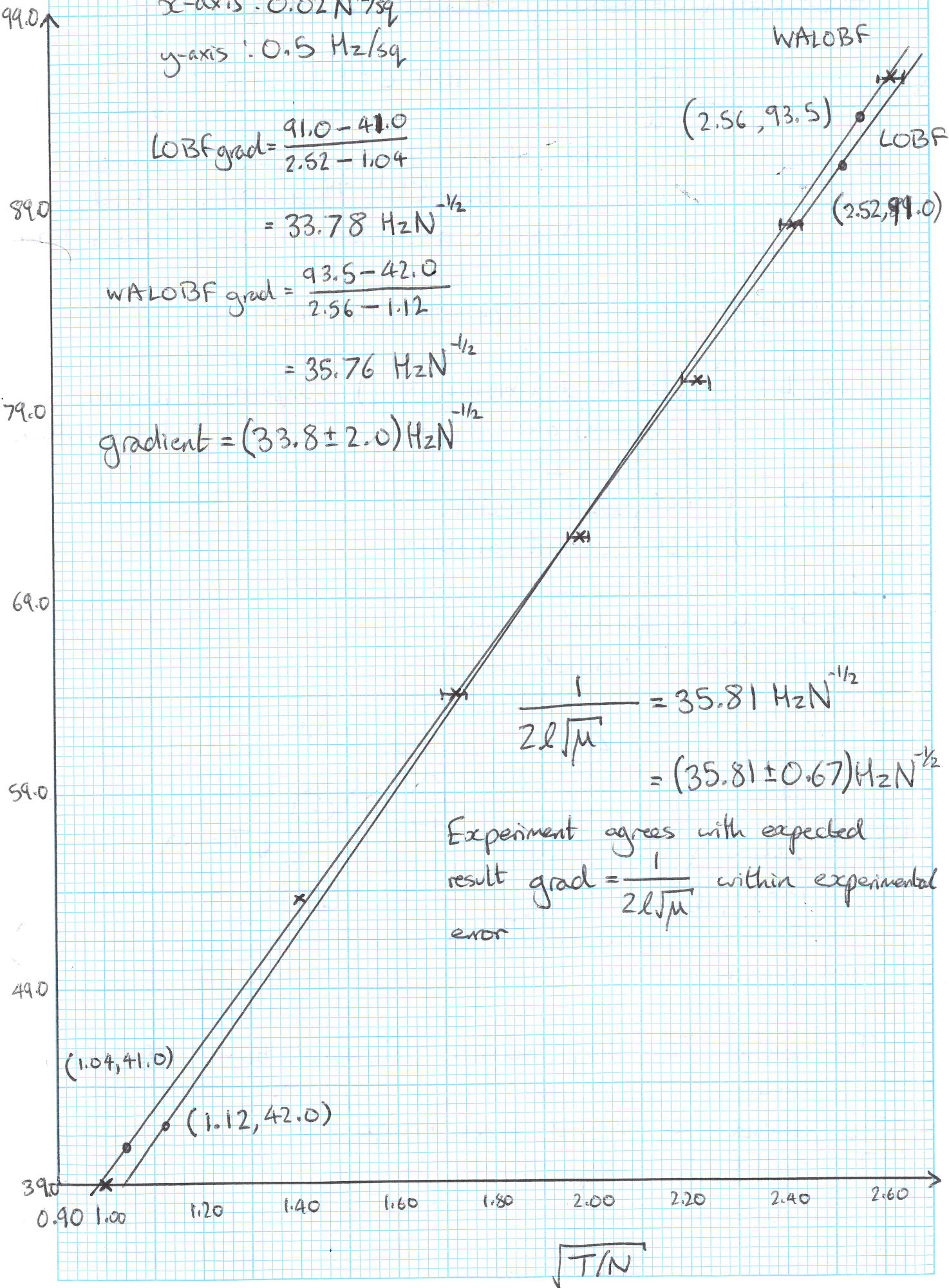
$$\text{LOBF grad} = \frac{91.0 - 41.0}{2.52 - 1.04}$$

$$= 33.78 \text{ Hz N}^{-1/2}$$

$$\text{WALOFB grad} = \frac{93.5 - 42.0}{2.56 - 1.12}$$

$$= 35.76 \text{ Hz N}^{-1/2}$$

$$\text{gradient} = (33.8 \pm 2.0) \text{ Hz N}^{-1/2}$$



Prac 3

x-axis: $2.0 (\text{m kg}^{-1})^{1/2} / \text{sq}$

y-axis: $2.0 \text{ Hz} / \text{sq}$

$$\text{LOBF grad} = \frac{172.0 - 46.0}{194.0 - 52.0}$$

$$= 0.88732 \text{ Hz m}^{1/2} \text{ kg}^{-1/2}$$

$$\text{WA LOBF grad} = \frac{188.0 - 34.0}{188.0 - 54.0}$$

$$= 1.1493 \text{ Hz m}^{1/2} \text{ kg}^{-1/2}$$

$$\text{gradient} = (0.89 \pm 0.26) \text{ Hz m}^{1/2} \text{ kg}^{-1/2}$$

$$\frac{\sqrt{F}}{2l} = 0.8578 \text{ Hz m}^{1/2} \text{ kg}^{-1/2}$$

$$= (0.858 \pm 0.013) \text{ Hz m}^{1/2} \text{ kg}^{-1/2}$$

Experiment agrees with expected result

$\text{grad} = \frac{\sqrt{F}}{2l}$ within experimental error

