Practical: investigating stationary waves

pre-practical:

1) How to keep p safe:

- wear goggles incase string snaps/breaks
- gloves to prevent wire cutting hands
- hang crush mat under masses and keep away from them incase they fall

2) Variables:

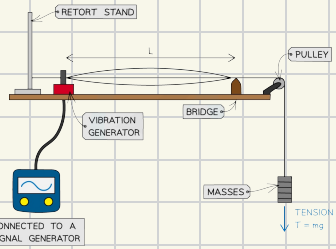
Control: masses attached (tension), same string.

independent: length of wire (cm measured with meter ruler)

dependent: frequency of first harmonic (Hz measured with signal generator)

Apparatus	Purpose
Signal generator	Used to operate the vibration generator and measure the frequency of the first harmonic
Vibration generator	Connected to the signal generator to produce the stationary wave
Retort stand	To provide a stable fixed end on the table
G clamp or 2 kg mass	To place on the retort stand to stabilise apparatus
2.0 m of string	Used to observe the stationary wave
Pulley	To allow the masses to hang vertically, and introduces less friction than the edge of the table
Wooden bridge	To provide the other fixed end which can vary the length of the string
Mass hanger + 100 g masses	To hang from the pulley to vary the tension in the string
Metre ruler	To measure the length of the string
Top-pan balance	To measure the mass of the string

Setting up the apparatus



Results table

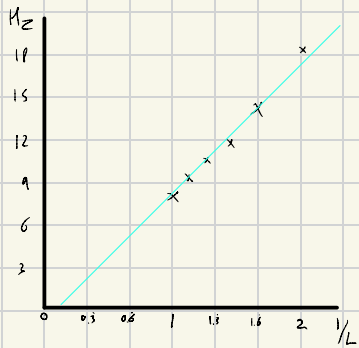
% uncertainty	LENGTH OF THE STRING L / m	FREQUENCY OF THE FIRST HARMONIC f/Hz 1st READING	f/Hz 2nd READING	f/Hz 3rd READING	f/Hz MEAN
0.6%	1	8 Hz	8 Hz	8.1 Hz	8 1/3 Hz
2.7%	0.9	9 Hz	9.5 Hz	9.375 Hz	9.29 Hz
0.67%	0.8	10.5 Hz	10.6 Hz	10.5 Hz	10.53 Hz
4.3%	0.7	11.5 Hz	11 Hz	12 Hz	11.5 Hz
0.8%	0.6	14.75 Hz	15 Hz	15 Hz	14.91 Hz
0% ?	0.5	18.25 Hz	18.25 Hz	18 Hz (anomaly)	18.25 Hz

L = ± 1mm = 0.1%

1/L = 16%

T = mg = 0.08 × 9.81 = 0.784

graph:



$\lambda = 2L \Rightarrow v = 2fL = \frac{2f}{1/L} = 2g$

so gradient x2 = wave speed

compare to $v = \sqrt{T/\mu}$

$\mu = \frac{0.004}{1.58} = 0.0025$

$v = \sqrt{\frac{0.784}{0.0025}} = \sqrt{280.28} = 16.741$

$g = \frac{2.2}{0.25} = 8.8$ $\quad 2g = 17.6$

to test accuracy 16.741 × 1.1 = 18.4

as 17.6 < 18.4 the readings are within the 10% range,

$\frac{17.6}{16.741} = 1.05$ so % difference is 5.1%

One way I could improve this experiment is by trying different tensions for each harmonic to get more accurate results

Steps to follow

1. Set up the apparatus by attaching one end of the string to the vibration generator and pass the other end over the bench pulley and attach the mass hanger
2. Adjust the position of the bridge so that the length L is measured from the vibration generator to the bridge using a metre ruler
3. Turn on the signal generator to set the string oscillating
4. Increase the frequency of the vibration generator until the first harmonic is observed and read the frequency that this occurs at
5. Repeat the procedure with different lengths
6. Repeat the frequency readings at least two more times and take the average of these measurements
7. Measure the tension in the string using T = mg
8. Measure the mass per unit length of the string μ = mass of string ÷ length of string