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PHYS 211X

Lab 10, Day 2: An exploration and discussion of Natural Frequency and Resonance, 3/28/2023,

Partners: Maite Valentin-Lugo, Seth Waln

Station 1: Elastic Band

1.

Driving Frequency: 50Hz

Tension	Antinodes
0.8	7
1.0	6
1.2	5
1.4	5
1.6	4
1.8	4

2.

Tension: 1N

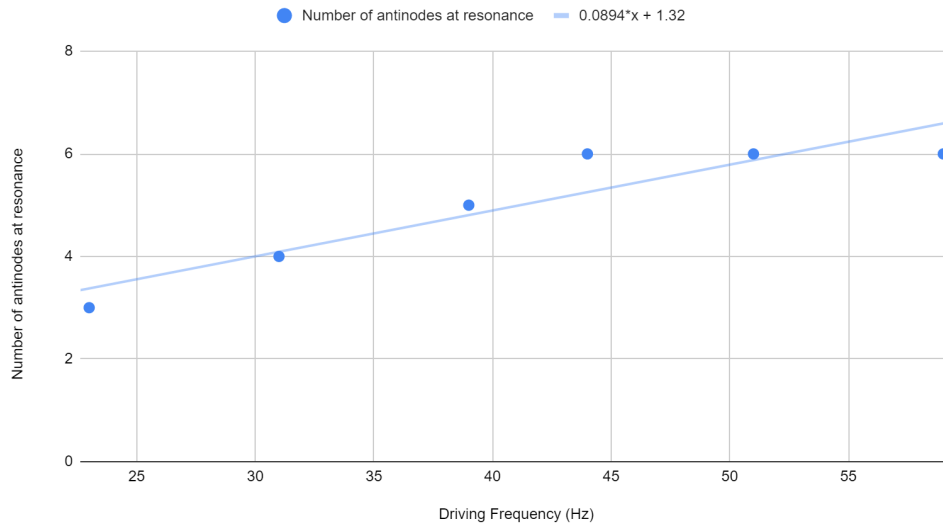
Driving Frequency	Antinodes
23	3
31	4
39	5
44	6
51	6
59	6

3.

$$v = \sqrt{\frac{T_s}{\mu}}$$
$$\lambda = \frac{v}{f}$$
$$\lambda \propto \frac{1}{\#A}$$
$$\frac{v}{f} \propto \frac{1}{\#A}$$
$$\frac{\sqrt{\frac{T_s}{\mu}}}{f} \propto \frac{1}{\#A}$$
$$\sqrt{\frac{T_s}{\mu}} \propto \frac{f}{\#A}$$

4.

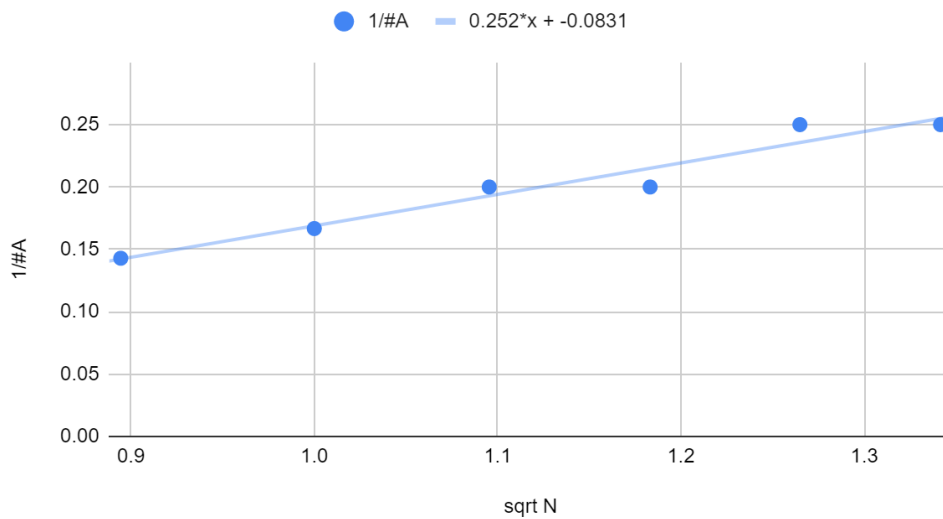
Number of antinodes at resonance vs. Driving Frequency (Hz)



Our data closely matches the predicted result of following a linear relationship, although it started to deviate past 40 Hz.

5.

1/#A vs. sqrt N



Our data very closely matched a linear regression, which tracks with the $\frac{1}{\#A}$ formula.

6.

	Tube 1	Tube 2	Tube 3
Resonant frequency	20 KHz	16 KHz	13 KHz
2nd Harmonic	39 KHz	32 KHz	25 KHz
3rd Harmonic	60 KHz	48 KHz	38 KHz

9.

$$\lambda = \frac{2L}{\#A} = \frac{v}{f}$$

$$f = \frac{\#Av}{2L} = \frac{1(343m/s)}{2(1.265m)} = 135.57Hz$$

$$\rightarrow \{13.5KHz, 27KHz, 40.5KHz\}$$

10.

Our prediction was relatively close, at worst it was $1 - \frac{38}{40.5} = 6.2\%$ off of the expected value, and at best was $1 - \frac{13}{13.5} = 3.7\%$ off of the expected value. This error is pretty acceptable given the rough nature of the materials we used.

11.

	Attached Mass	Resonant Frequency	Natural Frequency	% Difference
Stiff Spring	0.002	2.56	3.106	17.6%
Medium Spring	0.002	1.84	1.873	1.8%
Soft Spring	0.002	1.19	1.259	5.5%

12.

$$\sqrt{\frac{70g}{50g}} = 1.18$$

$$1.18 \cdot 2.56Hz = 3.02Hz$$

Real: 1.49 Hz, which is half of the predicted. We must have missed the first harmonic and got the second when we recorded.

13. Our prediction was relatively good, but we missed the first harmonic. Scaling the prediction down, we would expect 1.56Hz, which is $1 - \frac{1.49}{1.56} = 4.5\%$ off of our prediction, which is pretty good and on track with the differences we've found experimentally thus far.

14. The resonant frequency and natural frequencies we encountered seemed to be highly related in a 1:1 relationship with one another.

15.

	Natural Frequency Depends on:	How we drive the system:	At resonance observed, an increase in:
Elastic band	tension	Variable frequency mechanical oscillator	antinodes
Air column	length	Variable frequency speaker	amplitude
Mass on a Spring	Spring constant and mass	Variable frequency mechanical oscillator	amplitude