Measuring the wavelength of my string

In Lab Notes

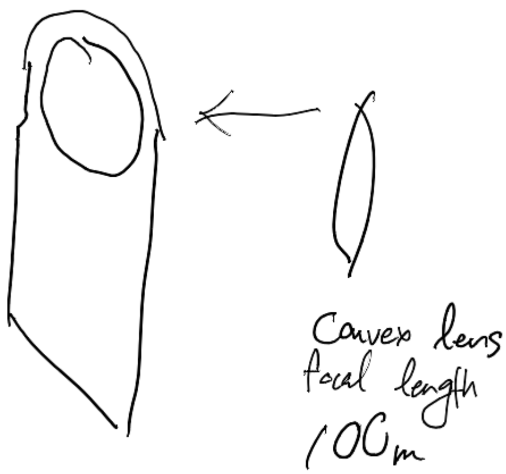
Date: 2024/12/04

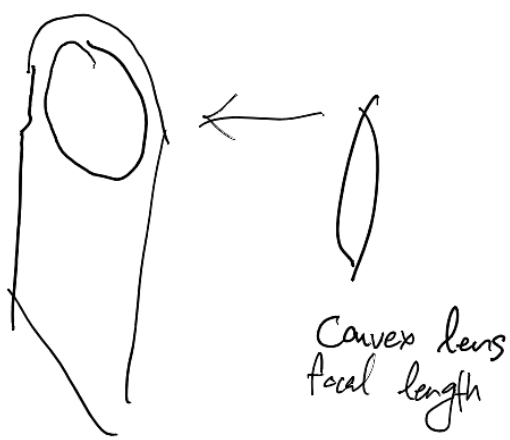
Starting Time: 16:30

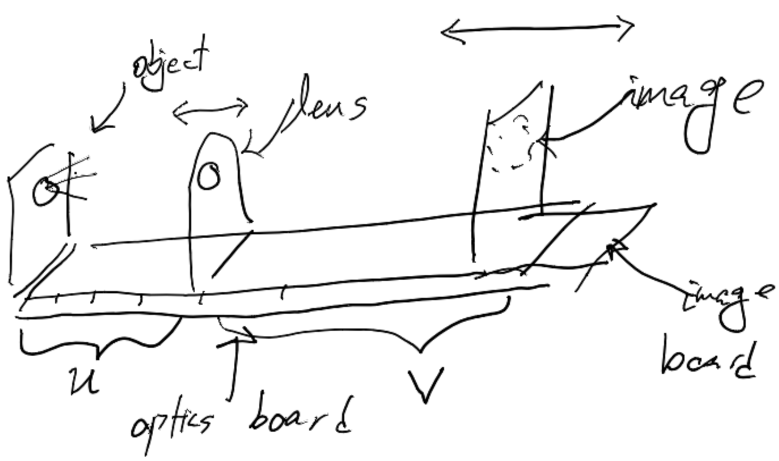
Goal: I want to measure the distance between the lens and the object and the distance between the lens and the screen. The measurements will be used to verify the lens formula in the out of lab notes.

Instruments:

- Optics light source
- Optics bench
- 100mm focal length lens
- 200mm focal length lens
- Image board


Convex lens
focal length
10Cm


Convex lens
focal length


object
lens
image
image board
u
optics board
V

Planning:

1. Place the object on the image board and set it exactly at 0cm. Then, plug it in so that the object emits light.
2. Place the 100mm focal length lens on the optics bench, 12.5cm away from the object (light source) .
3. Move the image board around until you find a sharp image. Record the distance between the object and the image five times.
4. Repeat the processes using a 200mm focal length lens for 15cm, 20cm, 30cm, 40cm being the distance from the lens to the object.
5. Place the 200mm focal length lens on the optics bench 30cm, 40cm, 50cm, 60cm, and 70cm being the distance from the lens to the object, and measure the distance between the object and the image.

I will only proceed the experiment using the 200mm focal length if I have enough time.

Reasoning:

I am not fully aware of optics. The only law that I know in optics is the lens law, where

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

f = focal length
u = object distance
V = image distance

. Since I have 2 different lenses with 2 focal lengths, I decided that confirming this equation, measuring the u and v would be very interesting. I first decided to make each measurement only once because there would be only one point where the image is the sharpest, but I remember in the past I have made this mistake. Making multiple measurements never hurt, and they help reduce random errors. I also decided to measure the distance between the object and the image, rather than the lens and the image because I can simply subtract the object distance from my measurement and gain the same data. This is also because the optics bench is comfortable measuring the distance between the object and the image.

I also chose this experiment because the out of lab experiment would be very neat. I would only have to plot a linear relationship between 1/v and 1/u.

The reason why I chose these distances such as 12.5cm, 15cm, 20cm, etc for the distance between the lens and the object is because the focal length is 10cm, so I thought these distances would be appropriate. Also, the optics board has a maximum length of 115cm so I could not choose an absurdly large distance between the object and the lens.

Measurements

100mm F.L

Object distance = U
Image-lens distance = V
Object-image distance: U+V

U (cm)	U+V (cm)	Calculated V (U+V)-U (cm)
12.5	66.3	53.8
	65.7	53.2
	65.3	52.8
	65.5	53.0
	65.1	52.6
15.0	47.2	32.2
	46.5	31.5
	45.7	30.7
	46.4	31.4
	46.9	31.9
20.0	40.0	20.0
	40.3	20.3
	40.3	20.3
	40.2	20.2
	40.2	20.2
30.0	45.3	15.3
	45.3	15.3
	45.2	15.2
	45.1	15.1
	45.1	15.1
40.0	53.2	13.2
	53.2	13.2
	53.3	13.3
	53.3	13.3
	53.3	13.3

200mm F.L.

U (cm)	u+V (cm)	Calculated V (u+V)-U (cm)
30.0	93.5	63.5
40.0	82.0	42.0
50.0	85.0	35.0
60.0	91.6	31.6
70.0	99.2	29.2

Notes

As I anticipated, the v decreased as u increased, following the inverse proportionality trend of the lens law. I would still need to check out of lab to see how numerically fit my data is. One difficulty I faced when measuring small u's were that it was very hard to determine where the image is the sharpest. There seemed to be a very big range where the image seemed very sharp. Also, there was a point where I first thought the image was not too sharp, but when I moved the image board around, I found out that it was actually the distance where the image is the sharpest. This was not a big issue when u increased. I was also happy that I decided to measure the data 5 times due to this. If I was naïve and thought that one measurement would be fine, there was a high chance that I would make a very imprecise measurement.

Since I did not have sufficient time, I only measured the data for the 200mm focal length lens once for each distance. I would have to use the resolution of the optic board, 1mm, as the uncertainty for this case. In the out-of-lab notes, I will try to make a linear plot, comparing with that of the ideal values. I will also measure the average v's for each u, and calculate the uncertainty of the v's and u's as well.

End time: 18:30