Physical Experiment I

Experimental Title

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(Your UESTC Number:2016200302027)

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Teaching Assistant: Yichao Chen

Date Performed:

Overall

Score

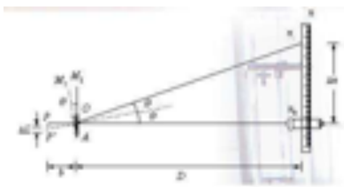
Abstract (About 100 words, 10 points)

Objective:

1.To let us know the definition of Young's modulus and where we usually use this figure.
2. To let us determine and try to get the Young's modulus of wire by using the elongation method.
3.To let us learn the principle of optical lever and master this method during these procedure. (including how we operate equipments, especially those accurate instruments, like vernier caliper and micrometer caliper…).
4.To help us to learn the calculation about how to get the uncertainty and let us know the principle used to analysis data.
5.To let us known the importance of standard of the data processing.

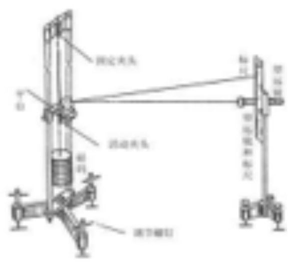
Theory:

1. Elongation method.
2. Hooke's Law.
3. Optical lever amplify.
4. Geometric relationship.



Operation:

1.First, adjusting the apparatus until and fully understand it. Make sure the safety of equipments and the accuracy (right or not) of the measurement.
2.Operating and measure experimental data and write them down to the table.
3.Use the data to calculate the Young's modulus.
4. At last, determine the uncertainty in this experiment.



Score

Calculations and Results (Calculations, data tables and figures; Use about 100 words to describe your results, 20 points)

$d_{average} = (d_1 + d_2 + d_3 + \cdots + d_9) / 9$

$= (0.587+0.588+0.587 \ +0.588+0.586+0.587+0.587+0.590+0.584) / 9$

=0.587mm＝0.000587m

The L_0 = 805.0mm, so it is 805mm.The D_0 = 1766.5mm, so it is 1767mm.
The b_0= 66.94mm, so it is 66.9mm.The following table is the length change of the wire(n_i)

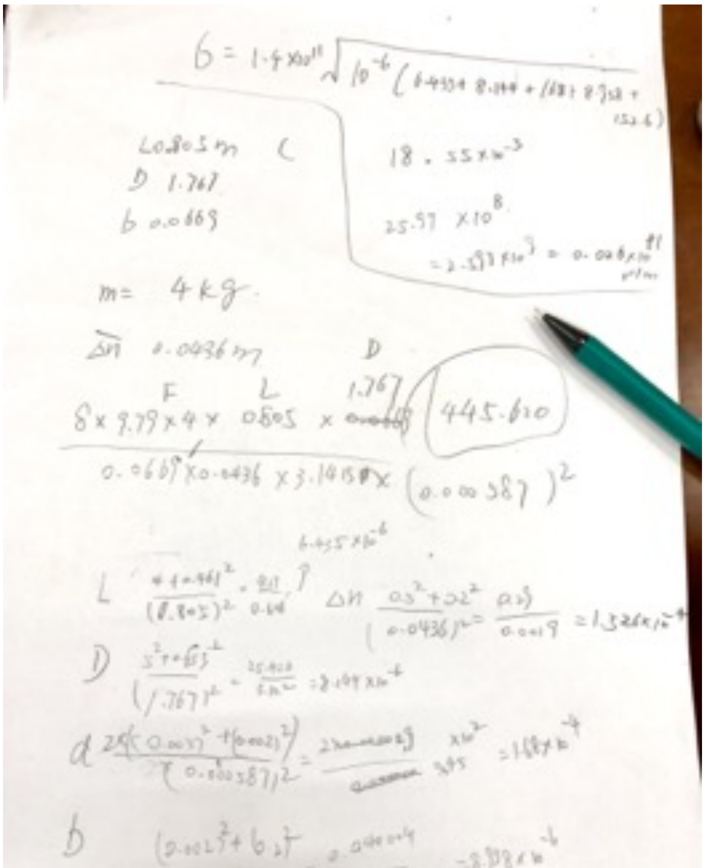
$\Delta_{1/n}$ =[ln₇ –n₃l+ln₆ –n₂l+ln₅ –n₁l+ln₄ –n₀l] / 4 = [(-29.0-(-69.5))+(-38.6-(-89.4))+(-49.0-(-90.0))+(-58.9-(-101.0))] / 4 = 43.6mm＝0.0436m

$$\overline{E} = \frac{8FLD}{b\overline{\Delta n}\pi \overline{d}^2} = \frac{455.620}{3.157} \times 10^9 = 1.4 \times 10^{11} (N/m^2)$$

$$\sigma_E = \overline{E} \times \sqrt{(\frac{\sigma_L}{L})^2 + (\frac{\sigma_D}{D})^2 + (2\frac{\sigma_d}{d})^2 + (\frac{\sigma_b}{b})^2 + (\frac{\sigma_{\overline{\Delta n}}}{\Delta n})^2} = 0.026 \times 10^{11} (N/m^2)$$

Note: (d is the diameter of wire. L_0 is the distance from the top of the optical lever to the mirror. D_0 is the distance from the mirror to the telescope. b_0 is the high of isosceles triangle which is formed by three fulcrum mirror device.)

$$\overline{E} = \overline{E} \pm \sigma_E (N/m^2) = (1.4 \pm 0.026) \times 10^{11} (N/m^2)$$



The photocopy of my calculating details.

Score

Answers to Questions (10 points)

(1)(a) Which question is more critical, the length of the wire or its elongation?

In my perspective, the elongation of length is more critical .Because the value is so precise and the change of length my have a relative high proportion change to it self when we couldn't measure it properly. Besides, according to the measurement of uncertainty, it is easy for as to find that the change of L has the greater influence on the experiment and it can easily cause relative errors.

(1)(b) Explain why the length of the wire is measured with a meter stick while a very sensitive length measuring device is required for the elongation?

Because the length of wire is extremely long when it compare with the elongation, it is quite suitable to use meter stick to measure as the error(uncertainty) can only influence a tiny proportion of the measurement, so this error can be ignored. However the elongation is too small that we couldn't skip its error as its relative error would be large and even some small error can cause a nth-fold deviation. So we should use more sensitive equipments to measure it.

(2)(a) The initial load on the hanger was not included in our calculation. Why not?

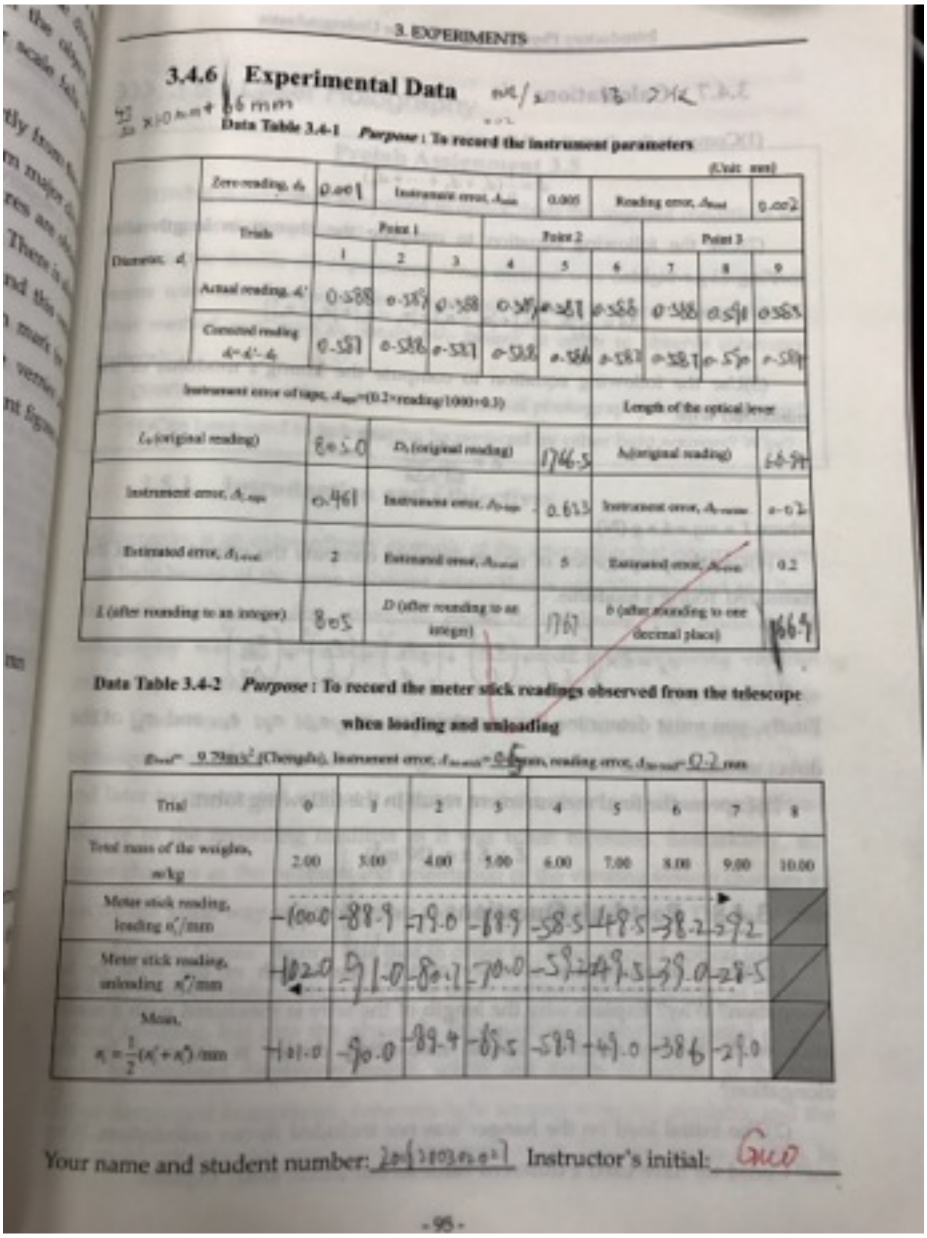
The initial load is used to keep the wire straight in order to help our measurement and to make sure the length, which is record by us, more accurately.

(2)(b)Could we have used a different value as our initial load? Explain.

When we analyze these data, we choose gradual education method and the initial weight will be subtracted during our calculation when we do our data analyze. We can choose our initial load freely in our experiment as the data analyze process use the difference between loads and we do not use the value of loads directly when we do our calculate to get the Young's Modulus. So initial weight have no influence on our final result.

Appendix

(Scanned data sheets)



3. EXPERIMENTS

3.4.6 Experimental Data

Data Table 3.4-1 *Purpose*: To record the instrument parameters

(Unit: mm)

Diameter, d	Zero reading, d_0	0.001	Instrument error, Δ_{inst}		0.005	Reading error, Δ_{read}			0.002
	Trials	Point 1			Point 2			Point 3	
		1	2	3	4	5	6	7	8	9
	Actual reading, d'	0.588	0.587	0.588	0.587	0.587	0.588	0.588	0.591	0.585
	Corrected reading $d=d'-d_0$	0.587	0.586	0.587	0.586	0.586	0.587	0.587	0.590	0.584

Instrument error of tape, Δ_{tape}=(0.2×reading/1000+0.3)				Length of the optical lever	
L_0 (original reading)	805.0	D_0 (original reading)	1766.5	b_0 (original reading)	66.94
Instrument error, $\Delta_{L\text{-}tape}$	0.461	Instrument error, $\Delta_{D\text{-}tape}$	0.653	Instrument error, $\Delta_{b\text{-}vernier}$	0.02
Estimated error, $\Delta_{L\text{-}est}$	2	Estimated error, $\Delta_{D\text{-}est}$	5	Estimated error, $\Delta_{b\text{-}est}$	0.2
L (after rounding to an integer)	805	D (after rounding to an integer)	1767	b (after rounding to one decimal place)	66.9

Data Table 3.4-2 *Purpose*: To record the meter stick readings observed from the telescope when loading and unloading

g_{local}= 9.79m/s² (Chengdu), Instrument error, $\Delta_{m\text{-}stick}$= 0.5 mm, reading error, $\Delta_{m\text{-}read}$= 0.2 mm

Trial	0	1	2	3	4	5	6	7	8
Total mass of the weights, m/kg	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
Meter stick reading, loading x_i'/mm	-100.0	-88.9	-79.0	-68.9	-58.5	-48.5	-38.2	-29.2	
Meter stick reading, unloading x_i''/mm	-102.0	-91.0	-80.1	-70.0	-59.[illegible]	-49.5	-39.0	-28.5	
Mean, $x_i=\frac{1}{2}(x_i'+x_i'')$/mm	-101.0	-90.0	-89.4	-69.5	-58.9	-49.0	-38.6	-29.0	

Your name and student number: 2016200302027 Instructor's initial: Guo

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The photocopy above is my data sheet. Some other photo records are at the next page.


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