PHYS115 PHYS121 PHYS123
PHYS116 PHYS122 PHYS124
Lab Cover Letter

Author (*You*) Trevor Signature: Trev

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Lab Partner(s) Lauren

Date Performed 05/09/2024 Date Submitted 05/09/2024

Lab (*such as #1: UNC*) #1-DLCIR

TA: Eli

GRADE (*to be filled in by your TA*) See your TA for detailed feedback.
An '*x*' next to a subcategory means you need to improve this aspect of your work.

Paper Subtotals (points)

( ) ***General*** **(6)**
_____ Sig. figs.
_____ Units
_____ Clarity of Presentation
_____ Format

( ) ***Abstract*** **(4)**
_____ Quantity or principle
_____ How measurement was made
_____ Numerical Results
_____ Conclusion

( ) ***Intro & Theory*** **(9)**
_____ Basic principle
_____ Main equations to be used
_____ Apparatus
_____ What will be plotted
_____ Fitting parameters related

( ) ***Exp. Procedures*** **(15)**
_____ Description
_____ Stating and justifying uncertainties
_____ Data Record
_____ Quality of Lab Work

( ) ***Analysis & Error Analysis*** **(20)**
_____ Discussion
_____ Equations & Calculations
_____ Presentation inc. Graphs, Tables
_____ Results Reported & Reasonable
_____ Underlined items addressed

( ) ***Discussion & Conclusions*** **(6)**
_____ Numerical comparison of results
_____ Logical conclusions
_____ Discussion of pos. errors
_____ Suggestions to reduce errors

( ) **Paper Total (60 points)**
(30 points for CME or EPF)

( ) **Notebook (10 points)**
_____ Format (*proper style, following directions*)
_____ Apparatus (*brief description of equipment, including sketches*)
_____ Data (*including computer file names and manually recorded data*)
_____ Experimental Technique (*describing your procedures; stating & justifying uncerts.*)
_____ Analysis (*results and errors*)

( ) **Worksheet(s)/Fill-in-the-Blank-Report (30 points)** *if applicable*

( ) **Adjustments –** late submissions, improper procedures, etc. – or bonus points for exceptional work.

( ) Total Grade

Graded by _____ (TA's initial)

PHYS 122-119B Lab 1: DC-CIR

Course & Section: PHYS 122-119B
Station 32

Section D: Ohm's Law

1.

DMM reading for the resistor

✓ **Answer**

$R = 99.5 \pm 0.1\Omega$

2.

List your data for minimum and maximum current, with error estimates. Don't forget units. Also, staple to this worksheet a copy of your plot, including the linear fit.

✓ **Answer**

$I_{min} = 21.4 \pm 0.1\ \text{mA} \quad V = 2.118 \pm 0.001\ \text{V}$
$I_{max} = 26.5 \pm 0.1\ \text{mA} \quad V = 2.620 \pm 0.001\ \text{V}$

3.

List your linear fit parameters, with error estimates from *Origin*

✓ **Answer**

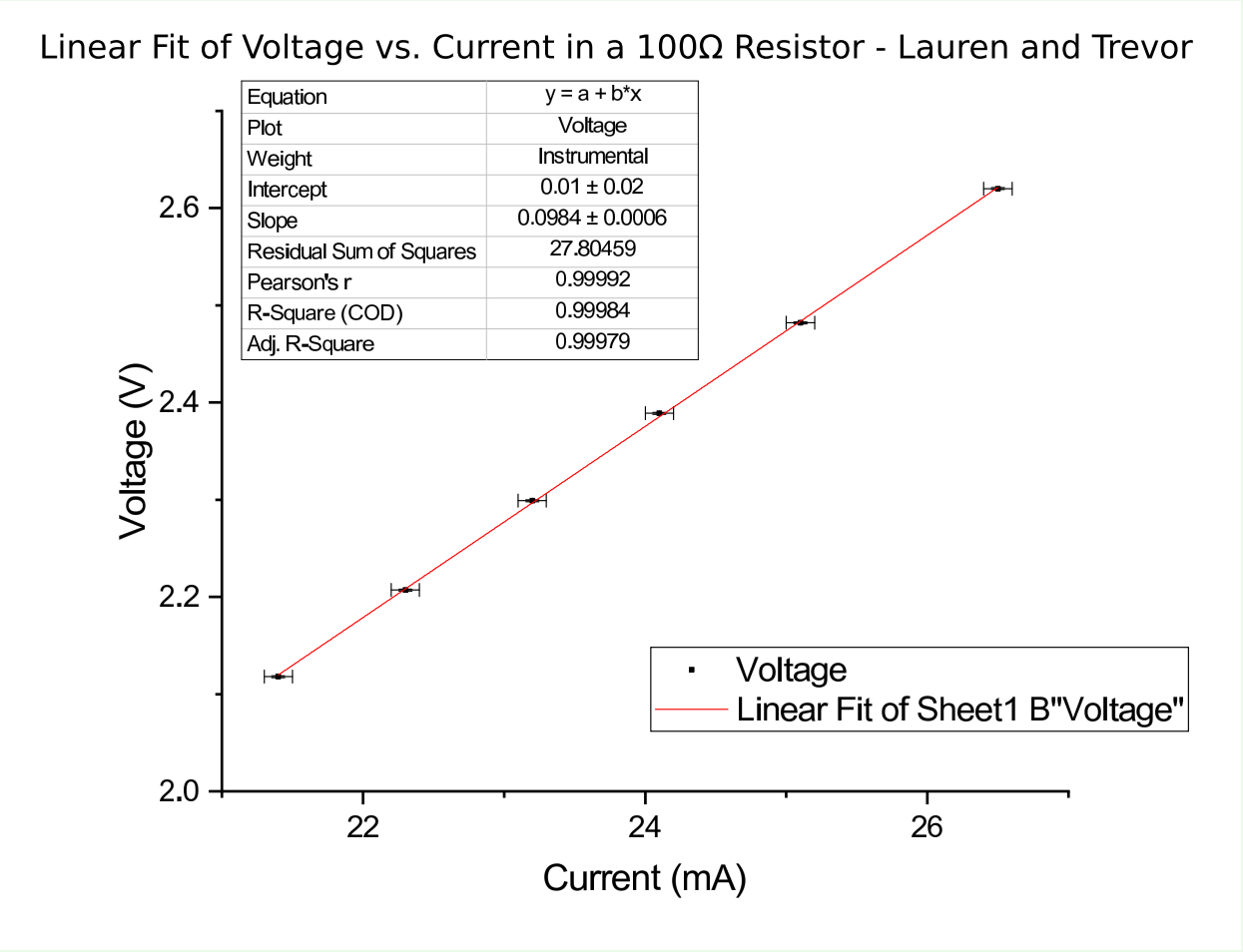
$\text{SLOPE: } 0.0984 \pm 0.0006\ \frac{\text{V}}{\text{mA}}$
$\text{INTERCEPT: } 0.01 \pm 0.02\ \text{V}$

4.

Comment on the comparison of the DMM value and Origin fit. (Use additional sheets if necessary)

✓ **Answer**

They are not particularly close, they are approximately 10SD away by the larger error, but I would trust the Origin result over the DMM as there is smaller error.



Section E.1: Series Resistors

5.

Enter below the data (with error estimates) for series resistors.

✓ **Answer**

Resistor #	Resistance Ω	Theoretical Sum Ω	Voltage V ± 0.001	Current mA	Experimental Sum Ω
1	$99.5 \pm 0.1\ \Omega$	$99.5\ \Omega$	2.703	27.4 ± 0.01	98.65 ± 0.05
2	$98.8 \pm 0.1\ \Omega$	$198.3\ \Omega$	2.789	14.1 ± 0.01	197.8 ± 0.2
3	$0.99 \pm 0.01\ \text{k}\Omega$	$1188.3\ \Omega$	2.866	2.239 ± 0.001	1280.0 ± 0.7
4	$47.1 \pm 0.1\ \Omega$	$1235.4\ \Omega$	2.867	2.161 ± 0.001	1326.7 ± 0.8

6.

Attach a sheet that describes in detail how you found the errors in each entry for two resistors in series. This should include errors in any raw data you took as well as error propagation through any equations that you used (see App. V of the lab manual)

✓ **Answer**

$R = \frac{V}{I}$
$\delta_{RV} = \frac{1}{I}$
$\delta_{RI} = \frac{V}{I^2}$
$\delta_R = \sqrt{\left(\frac{\delta_V}{I}\right)^2 + \left(\frac{V\delta_I}{I^2}\right)^2}$
□

7.

Compare the theory to the experiment. (Use additional sheets if necessary.)

✓ **Answer**

Our experimental sum was roughly in the same ballpark as the theoretical sum, but only within about 10SD of each other. I would say this is fairly bad, but they are relatively close in orders of magnitude.

Section E.2: Parallel Resistors

8.

Enter below the data from your table of part E.2 for parallel resistors.

✓ **Answer**

Resistor #	**Resistance** Ω	**Theoretical Sum** Ω	**Voltage** $\mathrm{V} \pm 0.001$	**Current** $\mathrm{mA} \pm 0.1$	**Experimental Sum** Ω
1	$99.5 \pm 0.1\ \Omega$	$99.5\ \Omega$	2.707	27.4	98.8 ± 0.4
2	$98.8 \pm 0.1\ \Omega$	$49.57\ \Omega$	2.548	51.7	49.3 ± 0.1
3	$0.99 \pm 0.01\ \mathrm{k}\Omega$	$47.21\ \Omega$	2.532	53.9	46.98 ± 0.09
4	$47.1 \pm 0.1\ \Omega$	$23.58\ \Omega$	2.259	96.4	23.43 ± 0.03

9.

Attach a sheet that describes in detail how you found the errors in each entry for 2 resistors in parallel.

✓ **Answer**

$R = \frac{V}{I}$
$\delta_{RV} = \frac{1}{I}$
$\delta_{RI} = \frac{V}{I^2}$
$\delta_R = \sqrt{\left(\frac{\delta_V}{I}\right)^2 + \left(\frac{V\delta_I}{I^2}\right)^2}$
□

10.

Compare the theory to the experiment. (Use additional sheets if necessary.)

✓ **Answer**

This time, my error was roughly within 4SD, which I would consider fairly close the the expected values.

Sections F & G: Where Ohm's Law Fails & Power Limits

11.

What resistance did you measure with the DMM?

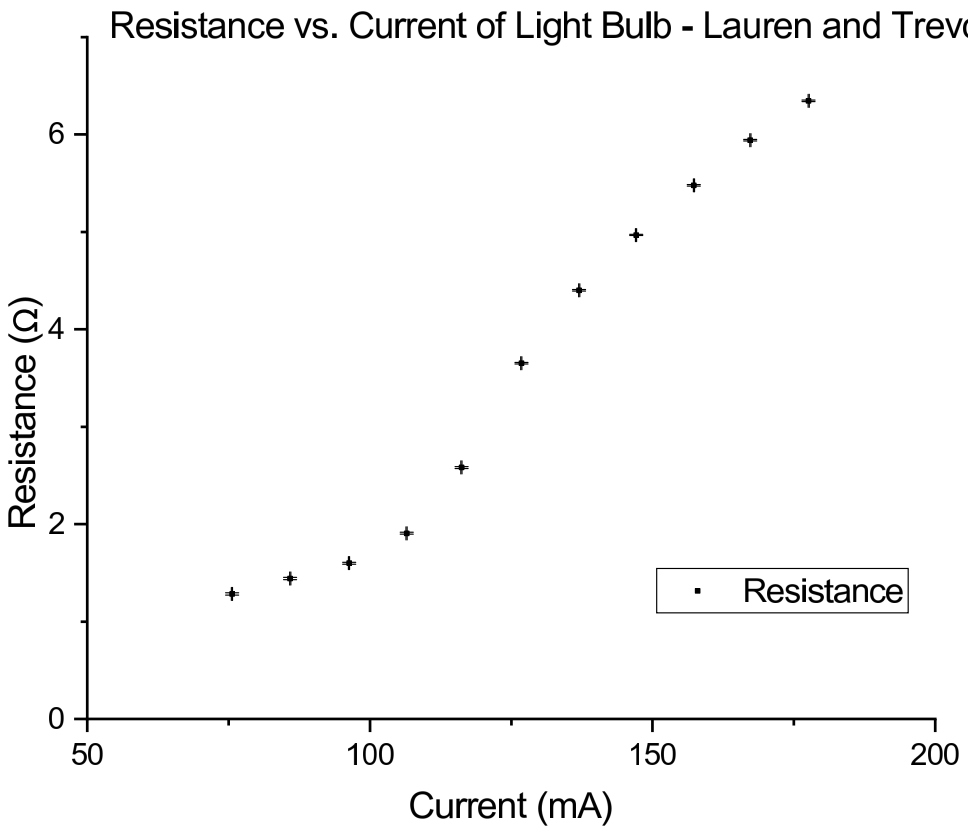
✓ **Answer**

$R = 1.7 \pm 0.1\ \Omega$

12.

Attach your Origin plot of $R\ vs.\ I$

✓ **Answer**



13.

Comment on Ohm's Law as it applies to the incandescent bulb and compare the DMM reading to the data in your plot: (Use additional sheets if necessary.)

✓ **Answer**

The resistance of the light bulb does not stay the same at around $1.7\ \Omega$, instead it non-linearly increases with the current. This is an unexpected result.

14.

What is the maximum rated voltage for a $100\ \Omega$, $\frac{1}{4}\ \mathrm{W}$ resistor

✓ **Answer**

$V = 5\ \mathrm{V}$

15.

What is your personal resistance?

✓ **Answer**

$R = 0.130 \pm 0.001\ \mathrm{M\Omega}$

16.

What voltage across your hands would result in a power that could destroy a $100\ \Omega$, $\frac{1}{4}\ \mathrm{W}$ resistor?

✓ **Answer**

$\frac{13000\ \Omega}{4\ \mathrm{W}} = V^2$
$V = 180\ \mathrm{V}$

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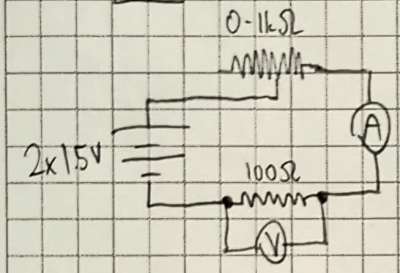
D

$V = IR$

$P = IV = I^2R = V^2/R$

Dg.1



$R = 99.5 \pm 0.1\ \Omega$

$A = 26.5 \pm 0.1$ nA $\quad V = 2.620 \pm 0.001$ V

$A = 21.4 \pm 0.1$ mA $\quad V = 2.118 \pm 0.001$ V

A (mA)	V (V)
21.4±0.1	2.118±0.001
22.3±0.1	2.207±0.001
23.2±0.1	2.299±0.001
24.1±0.1	2.389±0.001
25.1±0.1	2.482±0.001
26.5±0.1	2.620±0.001

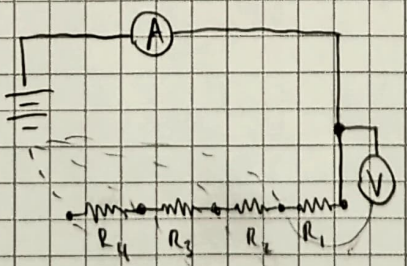
E1

$R_1 = 99.5 \pm 0.1\ \Omega$
$R_2 = 98.8 \pm 0.1\ \Omega$
$R_3 = 0.99 \pm 0.01\ k\Omega$
$R_4 = 47.1 \pm 0.01\ \Omega$

#	Theoretical (Ω)	V (V) ±0.001	I (mA) ±0.01	R_{eq} (Ω)	δ_R (Ω)
R_1	R_1 99.5	2.703	27.4	98.65	~~0.08~~ 0.05
$R_{1,2}$	R_1+R_2 198.3	2.789	14.1	197.8	0.16
$R_{1,2,3}$	$R_1+R_2+R_3$ 1188.3	2.866	2.239 ~~2.24~~ ±0.001	1280.0	0.73
$R_{1,2,3,4}$	$R_1+R_2+R_3+R_4$ 1235.4	2.867	~~2.25~~ 2.161 ±0.001	1326.7	0.77

$R = \frac{V}{I}$

$\delta_R = \sqrt{\left(\frac{\delta_V}{I}\right)^2 + \left(\frac{V\delta_I}{I^2}\right)^2}$



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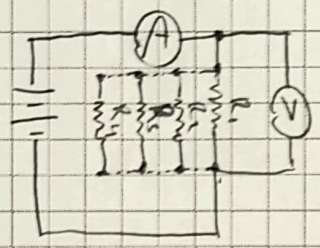
E2



$R_1 = 99.5 \pm 0.1\ \Omega$
$R_2 = 98.8 \pm 0.1\ \Omega$
$R_3 = 0.99 \pm 0.01\ k\Omega$
$R_4 = 47.1 \pm 0.01\ \Omega$

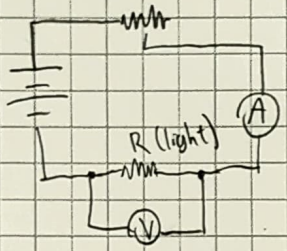
#	(Ω) Theoretical	(V) V	(mA) I	(Ω) R_{exp}	(Ω) δ_R
R_1	99.5	2.708 ±0.001	27.4 ±0.1	98.8	0.36
$R_{1,2}$	49.57	2.548 ±0.001	51.7 ±0.1	49.28	0.097
$R_{1,2,3}$	47.21	2.532 ±0.001	539 ±0.1	46.98	0.089
$R_{1,2,3,4}$	23.58	2.259 ±0.001	96.4 ±0.1	23.43	0.026

$$R = \frac{V}{I}$$

$$\delta_R = \sqrt{\left(\frac{\delta V}{I}\right)^2 + \left(\frac{V \delta_I}{I^2}\right)^2}$$

F

$R = 1.7\ \Omega$
± 0.1



± 0.1 I (mA)	± 0.001 V (V)	R_{eq} (Ω)
75.6	0.097	
177.6	1.127	
85.9	0.124	
96.3	0.154	
106.5	0.203	
116.2	0.300	
126.8	0.463	
137.0	0.603	
147.1	0.731	
157.3	0.862	
167.3	0.994	

G

$P = 0.25\ W$
$R = 100\ \Omega$

$\frac{100\ \Omega}{4\ W} = V^2$

$V = 5V$

Rated at 25V

$R = 0.130\ M\Omega$

$\frac{130{,}000\ \Omega}{4\ W} = V^2$

$V = 180V$