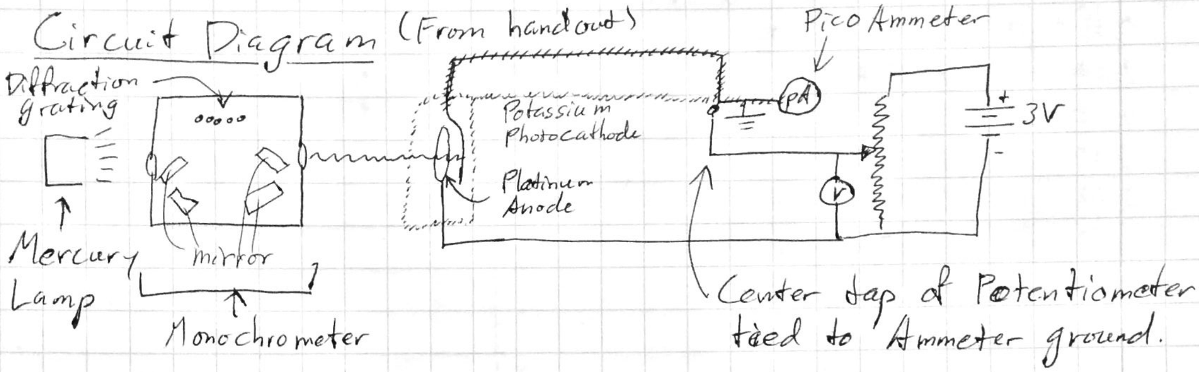
Determing Planck's Constant 1-26-15

Set-up, debugging, and initial study

Circuit Diagram (From handout)



Goal: (In our own words) We are attempting to determine the voltage required to stop a current produced by the photoelectric effect from a given light wavelength. There exists two seperate ~~that~~ methods, simply adjust the voltage until the current reads zero, and repeat for several wavelengths. The slope of ~~a~~ I vs. ν graph should be h. The alternate method is to graph I vs. V for a given wavelength, and extrapolate to find the stopping voltage. Do this for several wavelengths to then plot an (I vs. ν) graph to find the slope, h.

Visible

Actual CRC

- Dark Purple = ~~≈~~435.83 nm (CRC)
  @ ~ 422 nm (MC)

- Green = 546.07 nm (CRC)
  @ ~ 533 nm (MC)

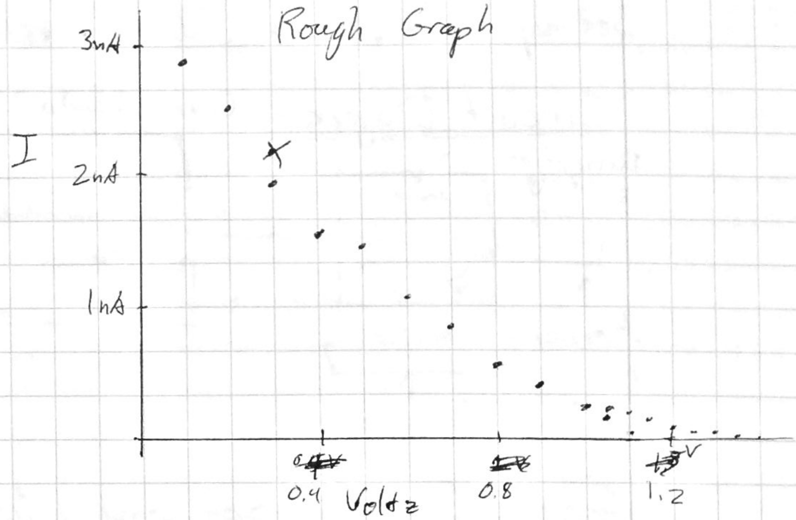
- Two Dark Yellow/Orange = 576.96 nm + 579.07 nm (CRC)
  @ ~ 563 nm (MC)

- Very Dark Purple = 404.66 (CRC)
  @ ~ 391 nm (MC)

- Ultraviolet (Not visible) = 365.02 nm (CRC) ← Used Ammeter to find
  @ ~~≈~~ 350 nm (MC)

@ 365.02 nm (CRC) Band

Voltage (V)	Amperage (nA)
0.0 ± .01	2.832 nA ± 0.003 nA
0.~~00~~10 ± .01	2.562 ± 0.002
~~0.20~~	~~2.256 ± 0.002~~ 65
0.20	2.265
0.30	1.967
0.40	1.691
0.50	1.406
0.60	1.115
0.70	0.854
0.80	0.637 ± 0.002
0.90	0.431
1.00	0.298
1.05	0.244
1.10	0.200
1.15	0.154
1.20	0.120
1.25	0.087
1.30	0.056
1.35	0.027
1.37	0.017
1.39	0.007
1.40	0.002
1.41	0.000 ± 0.002

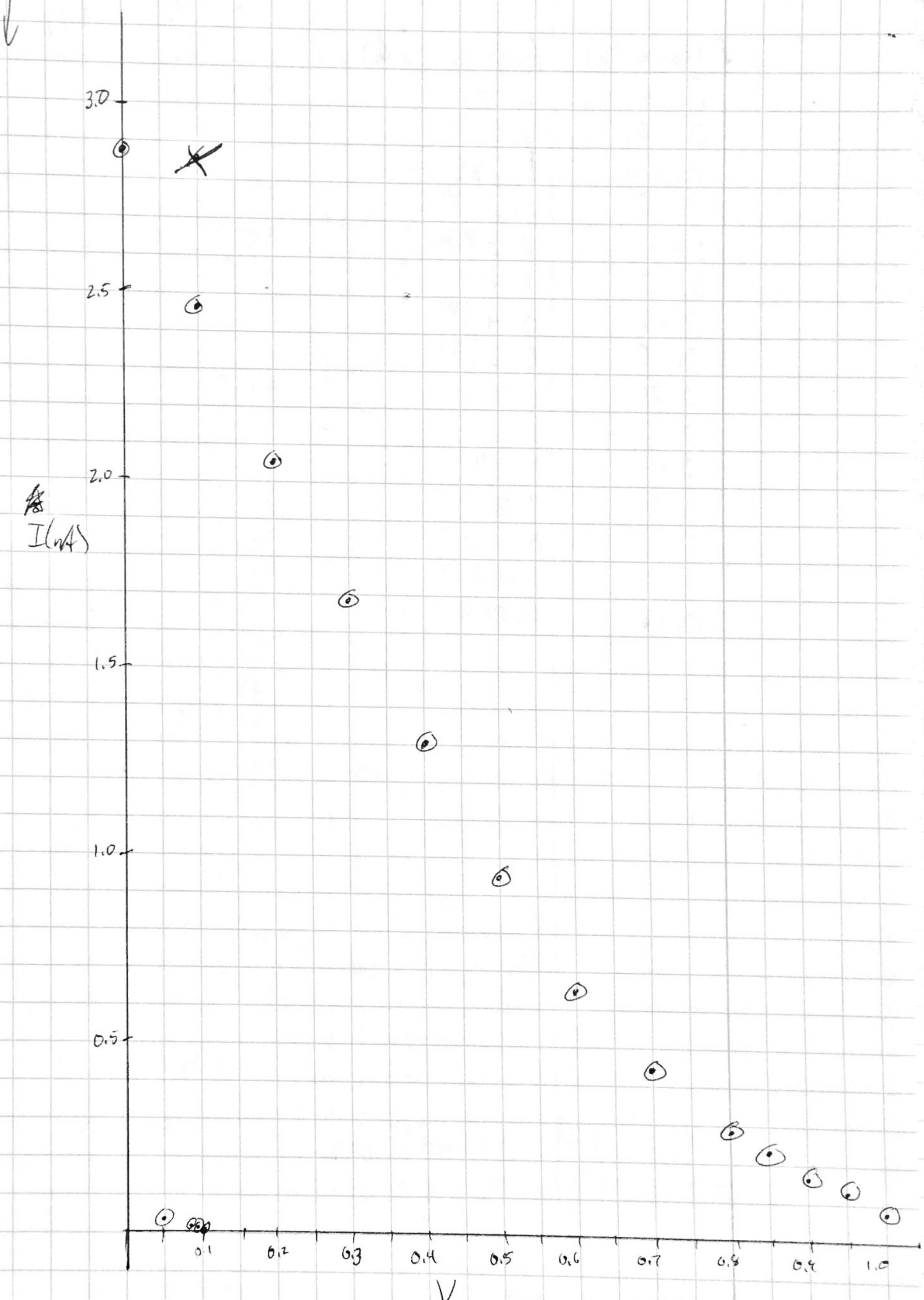


Quick guess of it

$\boxed{1.41\ eV \quad , \quad 8.2 \times 10^{14}}$

@ 404.6nm (CRC), 390 (CRC)   top V = 1.10

(V) Voltage	Amperage (nA)
0.00 ±0.01	2.865 ±0.002
0.10 ↓	2.477 ↓
0.20	2.060
0.30	1.693
0.40	1.301
0.50	0.951
0.60	0.651
0.70	0.442
0.80	0.289
0.85	0.231
0.90	0.175
0.95	0.123
1.00	0.079
1.05	0.036
1.08	0.012
1.09	0.006
1.10	0.000



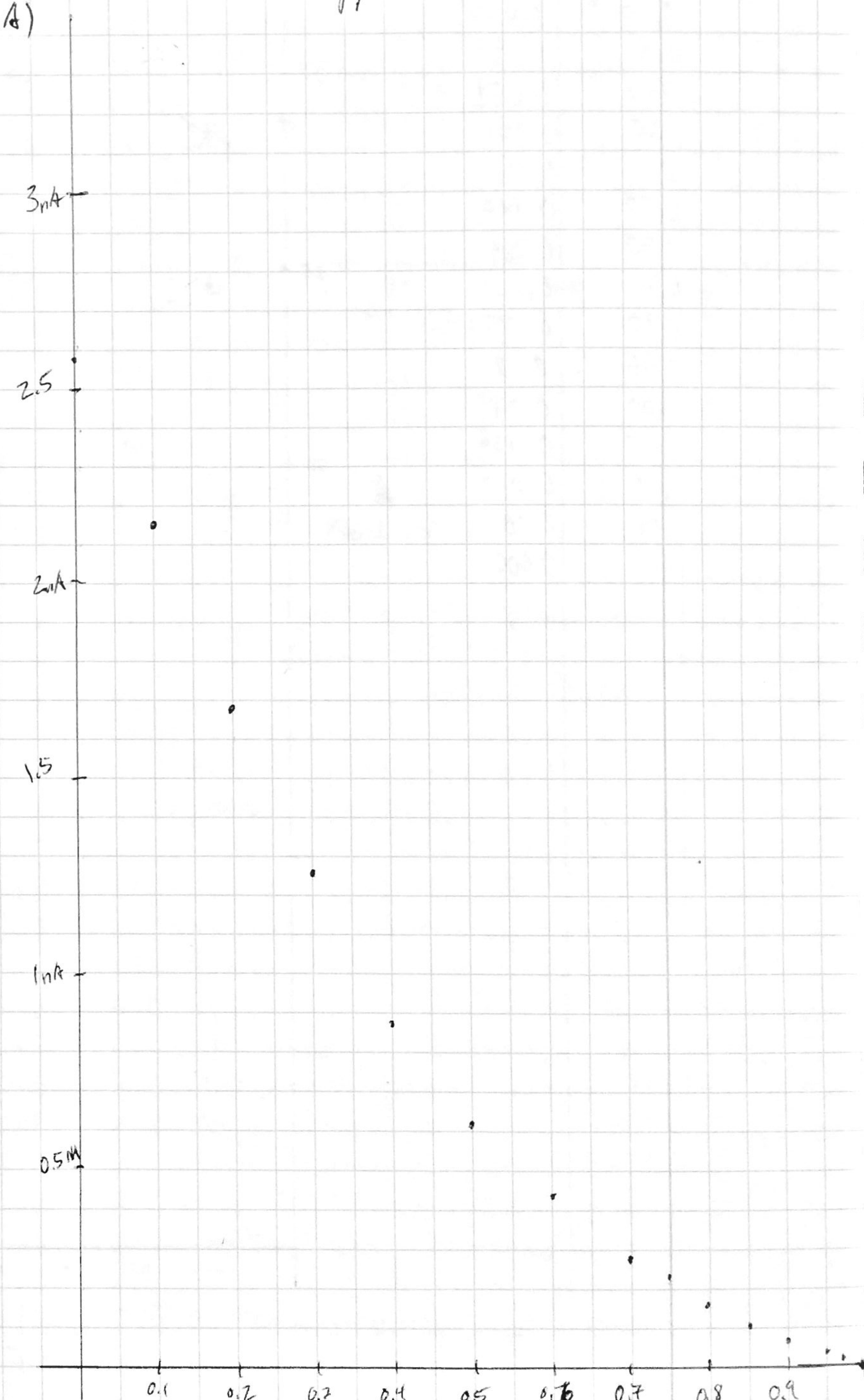
1.1 eV   7.41 × 10[14]

~~Determinging~~ Determining Planck's Constant 2-1-16

Data collection and analysis
@ 435.83 nm (CRC)

~0.98 V stopping

Voltage (V)	Amperage (nA)
0.00	2.580
0.10	2.147
0.20	1.688
0.30	1.249
0.40	0.873
0.50	0.610
0.60	0.434
0.70	0.285
0.75	0.219
0.80	0.161
0.85	0.104
0.90	0.060
0.95	0.020
0.97	0.008
0.98	0.000



2-1-16

[illegible] [illegible]

@546.07nm (CDC)

Voltage (V)	Amperage (nA)
0.00	0.105
0.10	0.077
0.20	0.052
0.30	0.030
0.40	0.017
0.45	0.011
0.50	0.007
0.52	0.006
0.55	0.003
0.56	0.000

≈0.95

@576.96 nm (CRC)

Voltage (V)	Amperage (nA)
0.00	0.015
0.02	0.014
0.03	0.013
0.04	0.013
0.05	0.012
0.06	0.012
0.08	0.011
0.10	0.010
0.12	0.009
0.14	0.008
0.16	0.008
0.18	0.008
0.20	0.007
0.22	0.006
0.24	0.006
0.25	0.005
0.26	0.005
0.27	0.005
0.28	0.004
0.30	0.004
0.32	0.004
0.33	0.003
0.39	0.002
0.43	0.001
0.48	0.000

* Def notation

0.33 → 0.003
0.39

Means for all points
0.33, 0.34, ..., 0.38 = 0.003
and 0.39 = 0.002

This was done as at lower amperages (higher voltages), multiple centivolts shared an amperage, so only the ~~new~~ voltage at which the new amperage was shown.

@ 579.07 nm (CRC)

Voltage (V)	Amperage (nA)
0.00	0.013
0.02	0.012
0.04	0.012
0.06	0.011
0.08	0.010
0.10	0.009
0.12	0.009
0.14	0.008
0.17	0.007
0.19	0.006
0.24	0.005
0.28	0.004
0.32	0.003
0.37	0.002
0.43	0.001
0.48	0.000

Data analysis done in Jupyter Notebook, uploaded to gitHub @

Paper Outline

Abstract: - Determing which method is more accurate for finding Planck's constant.
- Results for Simple vs. alternate methods

Problem / Relevant Theory: - Historical Background
- Misconceptions about work
- Theory

Experiment: - System setup
- Light wavelengths used
- Simple method
- Alternate method

Data + Error Analy.: - Graph that shows all wavelengths
- Sample wavelength
- high + low slopes
- Simple vs. alternate
- Errors

Conclusion: - Which method is better, simple, alternate

Test for 436 nm: Extrapolating down

Linear best fit => nA = -4.312 (V) + 2.570

$$V = \frac{2.570}{4.312}$$

Error Analysis

$eV = h\nu \qquad \nu = \frac{c}{\lambda} \qquad \Rightarrow eV = \frac{hc}{\lambda}$

$h = \frac{(eV)(\lambda)}{c} \qquad \frac{h}{e} = \frac{V\lambda}{c} \qquad V = \frac{h}{e}\frac{c}{\lambda}$

$\alpha = \frac{\Delta h}{e} = \sqrt{(\partial_V \alpha \, \Delta V)^2 + (\partial_\lambda \alpha \, \Delta \lambda)^2}$

$= \cancel{\sqrt{(\lambda/c)^2}} + ($

$= \sqrt{(\lambda/c \, \Delta V)^2 + (V/c \, \Delta \lambda)^2}$

$=$