☐PHYS115 ☐PHYS121 ☑PHYS123
☐PHYS116 ☐PHYS122 ☐PHYS124
Lab Cover Letter

Author (*You*) Trevor N. Signature: Trvr N.

I declare that this assignment is original and has not been submitted for assessment elsewhere, and acknowledge that the assessor of this assignment may, for the purpose of assessing this assignment: (1) reproduce this assignment and provide a copy to another member of faculty; and/or (2) communicate a copy of this assignment to a plagiarism checking service (which may then retain a copy of this assignment on its database for the purpose of future plagiarism checking).

Lab Partner(s) Lauren Lee

Date Performed 2024-10-31 Date Submitted 2024-11-04

Lab (*such as #1: UNC*) #4 MAG & IND

TA: Phillip

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)*

5

Lab 5 Worksheet


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Trevor Nichols, Lauren Lee
PHYS 122-119B
Station 31
Lab 5: MAG&IND
2024-11-04T00:26:58-04:00

Department of Physics,
Case Western Reserve University,
Cleveland, Ohio,
44106-7079
```


MAG

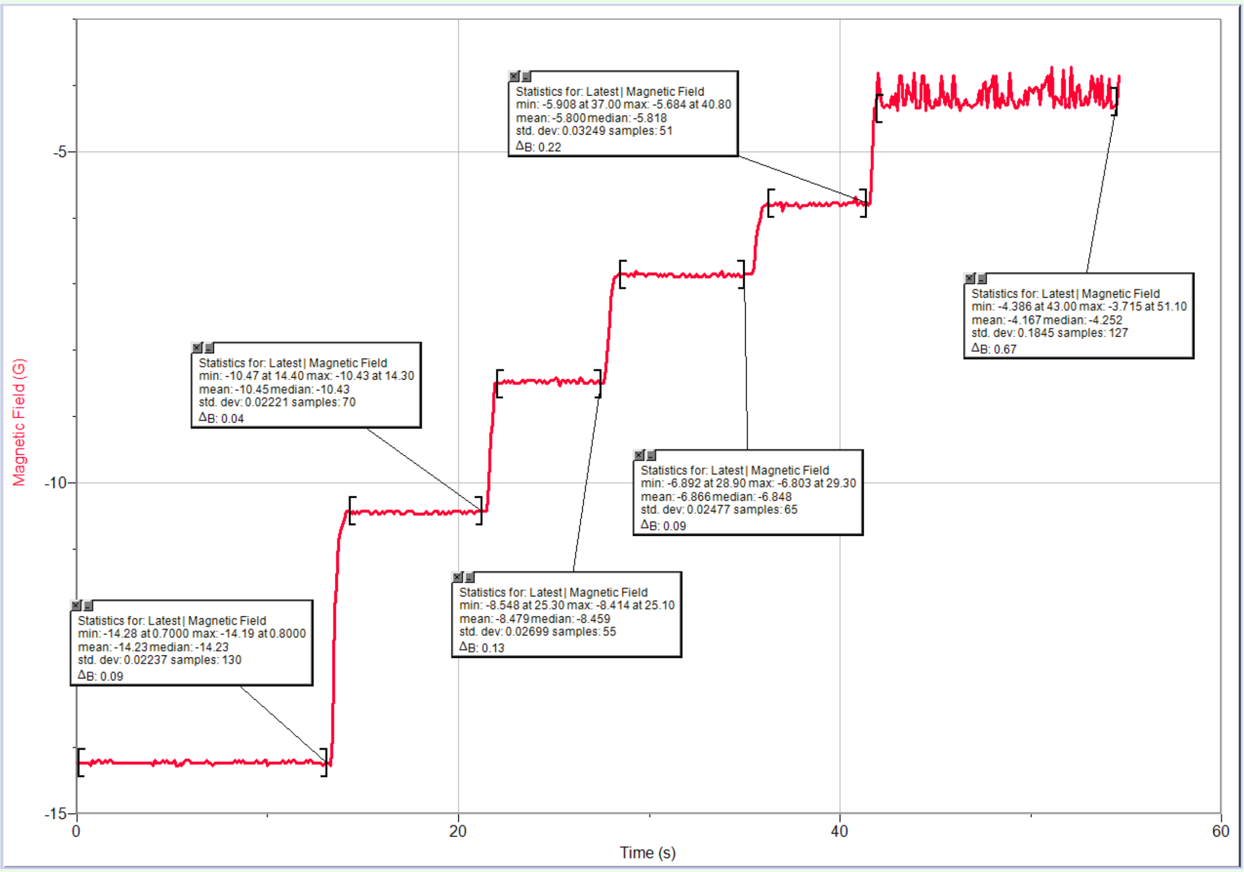
1

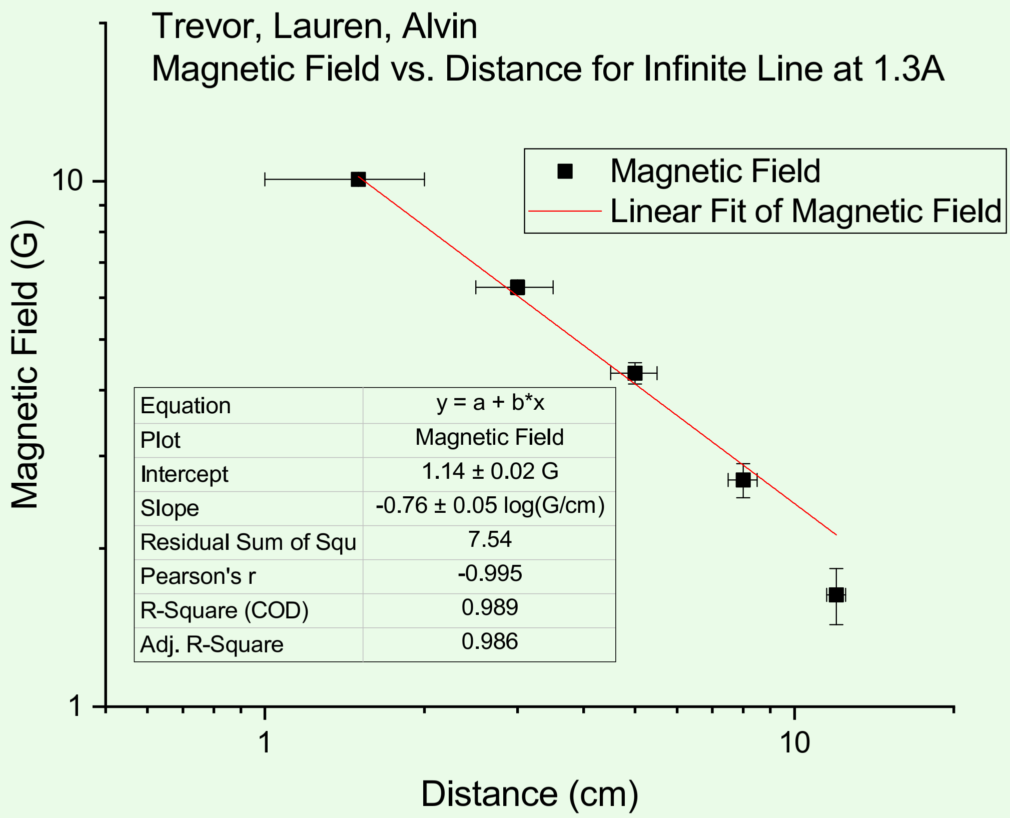
For section D.3, Long Wire:

Attach a copy of one of the LoggerPro plots and your graph to this worksheet:

Report your value for the exponent of the power law as a measurement interval.
Is this consistent with the theoretical value? Explain.

Answer





We got a value of -0.76 ± 0.05, which is not exactly close to 1, but is still within 5 STD of our expected value.

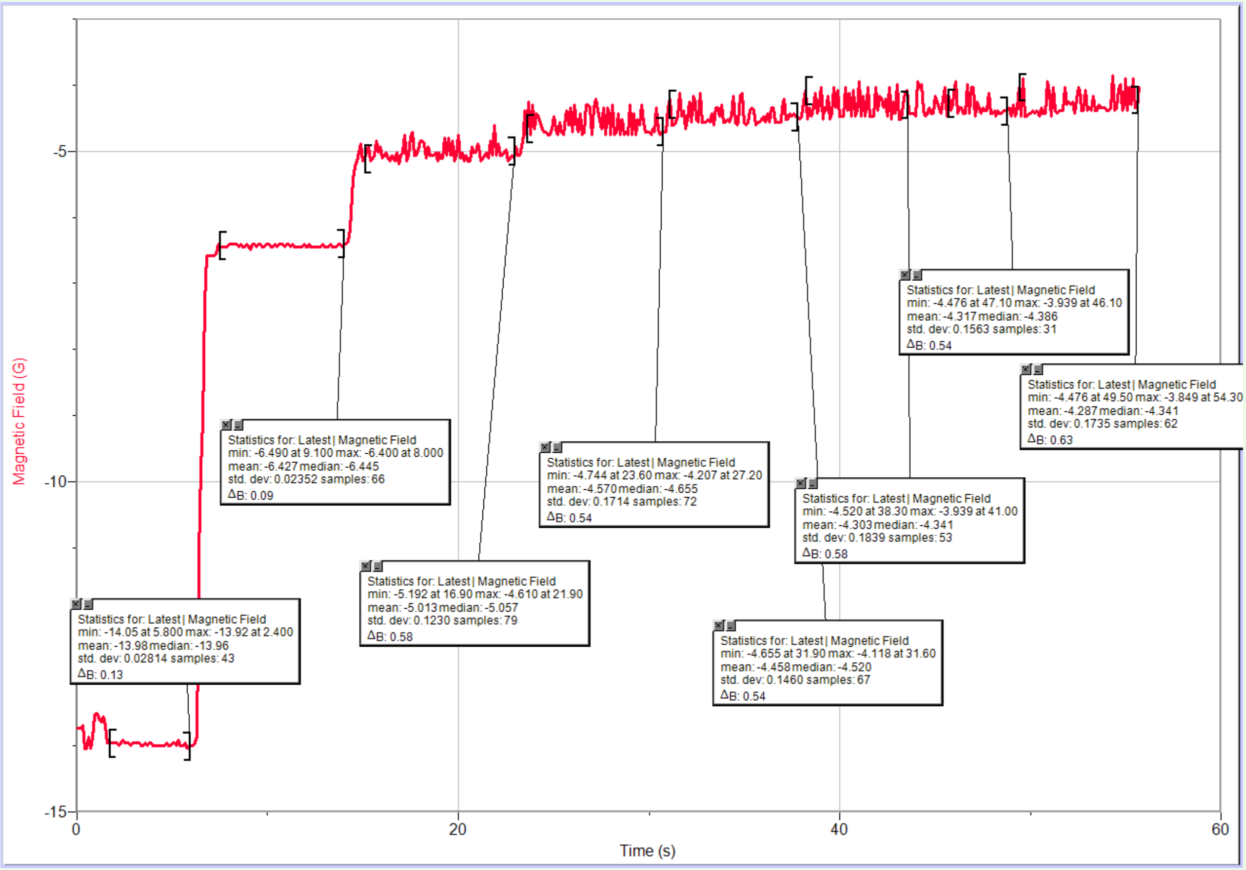
2

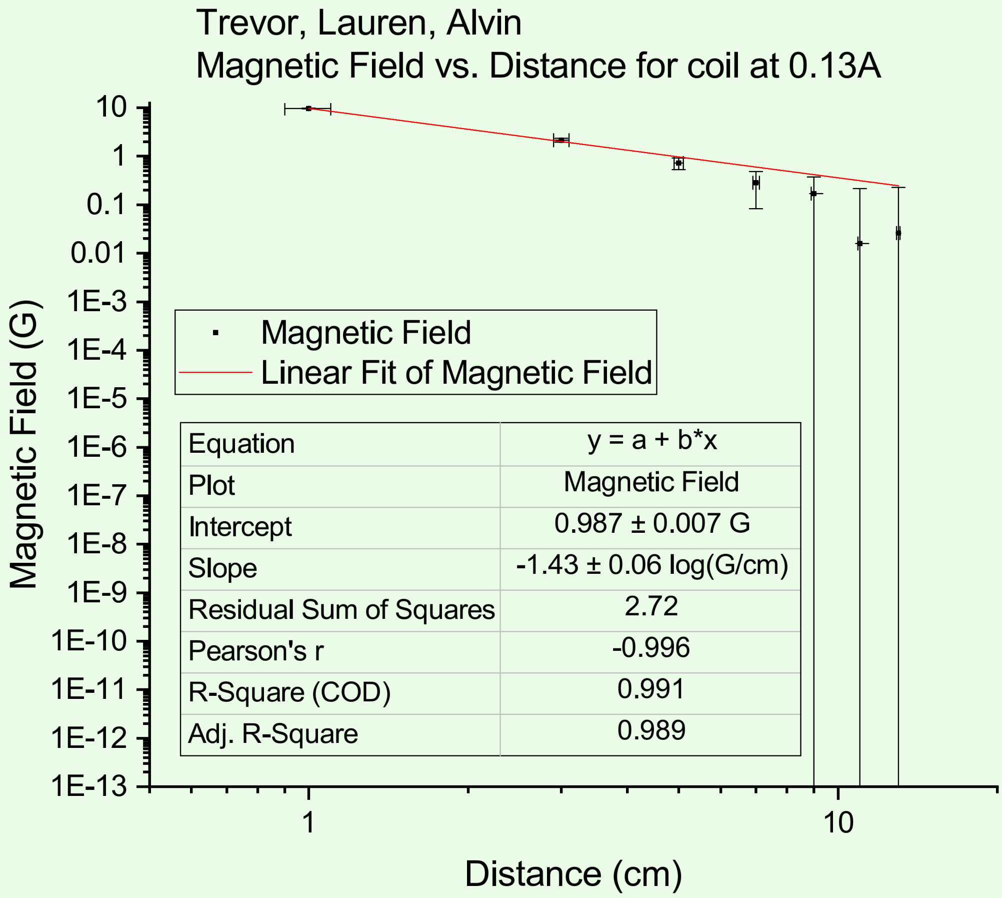
For section D.4, Coils:

Attach a copy of your graph to this worksheet:

Report your value for the exponent of the power law as a measurement interval.
Is this consistent with the theoretical value? Explain.

Answer





Equation	y = a + b*x
Plot	Magnetic Field
Intercept	0.987 ± 0.007 G
Slope	-1.43 ± 0.06 log(G/cm)
Residual Sum of Squares	2.72
Pearson's r	-0.996
R-Square (COD)	0.991
Adj. R-Square	0.989

We got a value of -1.45 ± 0.06, which is fairly close to -1.5, which is our expected value for the theoretical equation.

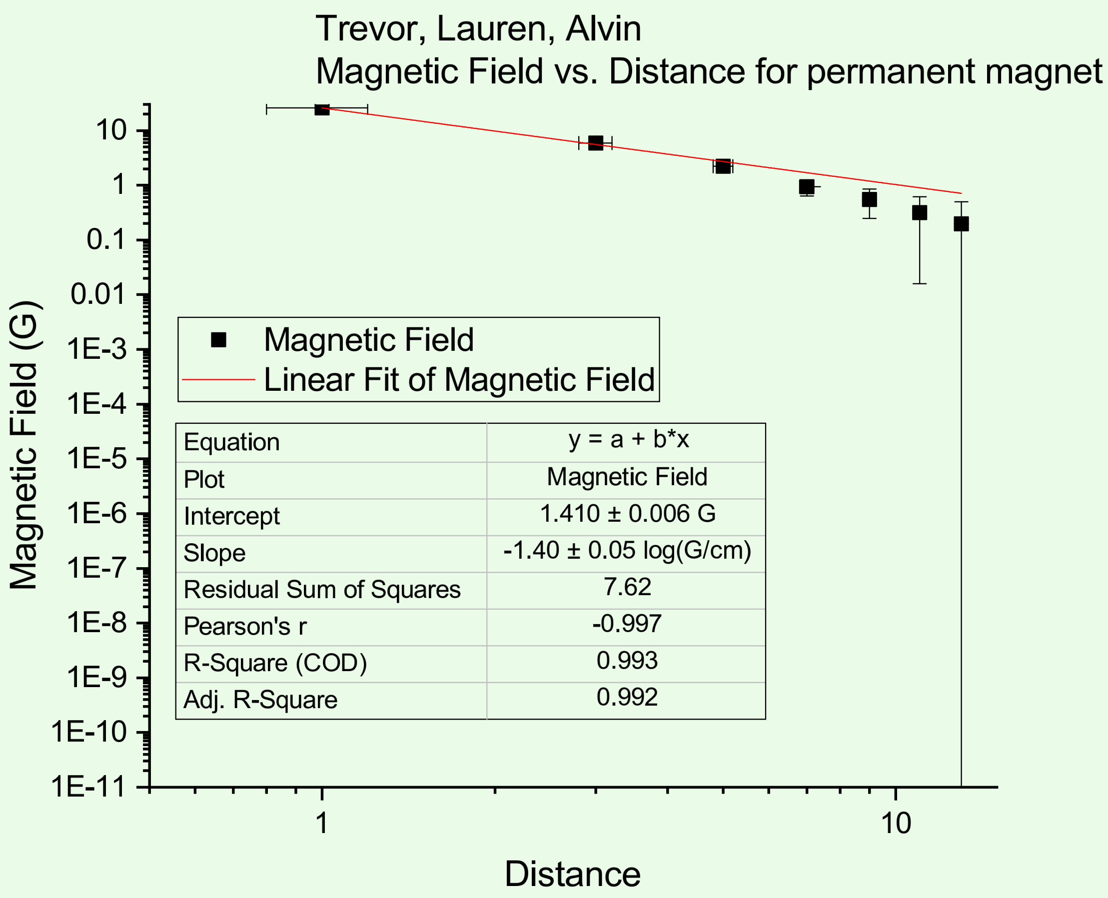
3

For section D.5, Disk Magnet:

Attach a copy of your graph to this worksheet:

Report your value for the exponent of the power law as a measurement interval. Compare this value to your value for the coil.

✓ **Answer**



We got a value of -1.40 ± 0.05, which is fairly close to -1.5, which is our expected value for the theoretical equation.

IND

1

For section D.2.2, with the rectangular coil:

What was the largest (positive or negative) induced EMF you found for:

i

motion of the coil outside the magnet, about 40 cm away

> ✓ **Answer**
>
> Roughly $-0.011\ V$

ii

motion over the magnet with coil ends kept from crossing the boundary

> ✓ **Answer**
>
> Roughly $-0.021\ V$

iii - iv

40 cm-to-center motion, center-to-40 cm
Explain why the sign of the EMF change between these two directions.

Record the values of the integrals for each part of the motion (Don't forget units.)

40 cm-to-center motion, center-to-40 cm
Why should these two integrals be equal in magnitude and opposite in sign
Remember to attach a copy of your LoggerPro scan for measurement iii.

Record the maximum magnitude of the EMF for your two other speeds?

Motion 40 cm to center: slower, faster
Motion center to 40 cm: slower, faster

Explain why the magnitude changed with speed.

Record the value of the integral over time of the EMF for fast motion, slow motion

Are the integrals for the two different speeds the same? Should they be? Explain why or why not.

> ✓ **Answer**
>
> | | Max/Min | Integral |
> |---|---|---|
> | Slow/Center | $0.167\ V$ | $0.09059\ Vs$ |
> | Slow/Back | $-0.239\ V$ | $-0.06924\ Vs$ |
> | Normal/Center | $0.396\ V$ | $0.06177\ Vs$ |

	Max/Min	Integral
Normal/Back	$-0.405\ V$	$-0.08926\ Vs$
Fast/Center	$0.587\ V$	$0.04096\ Vs$
Fast/Back	$-1.274\ V$	$-0.1269\ Vs$

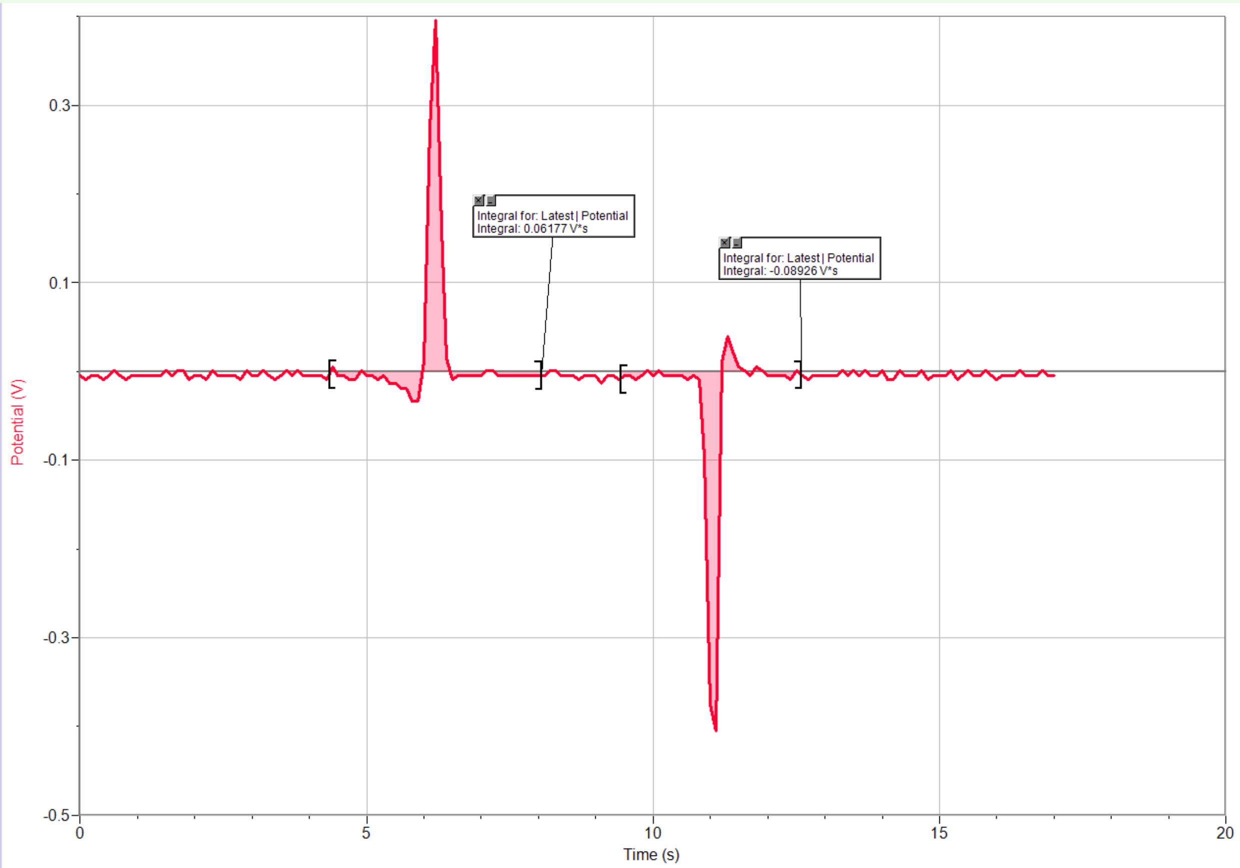
Since magnetic flux is conservative, its path integral will remain the same no matter what path is taken from initial point to ending point.

This also means that the reverse path will have the inverse integral.

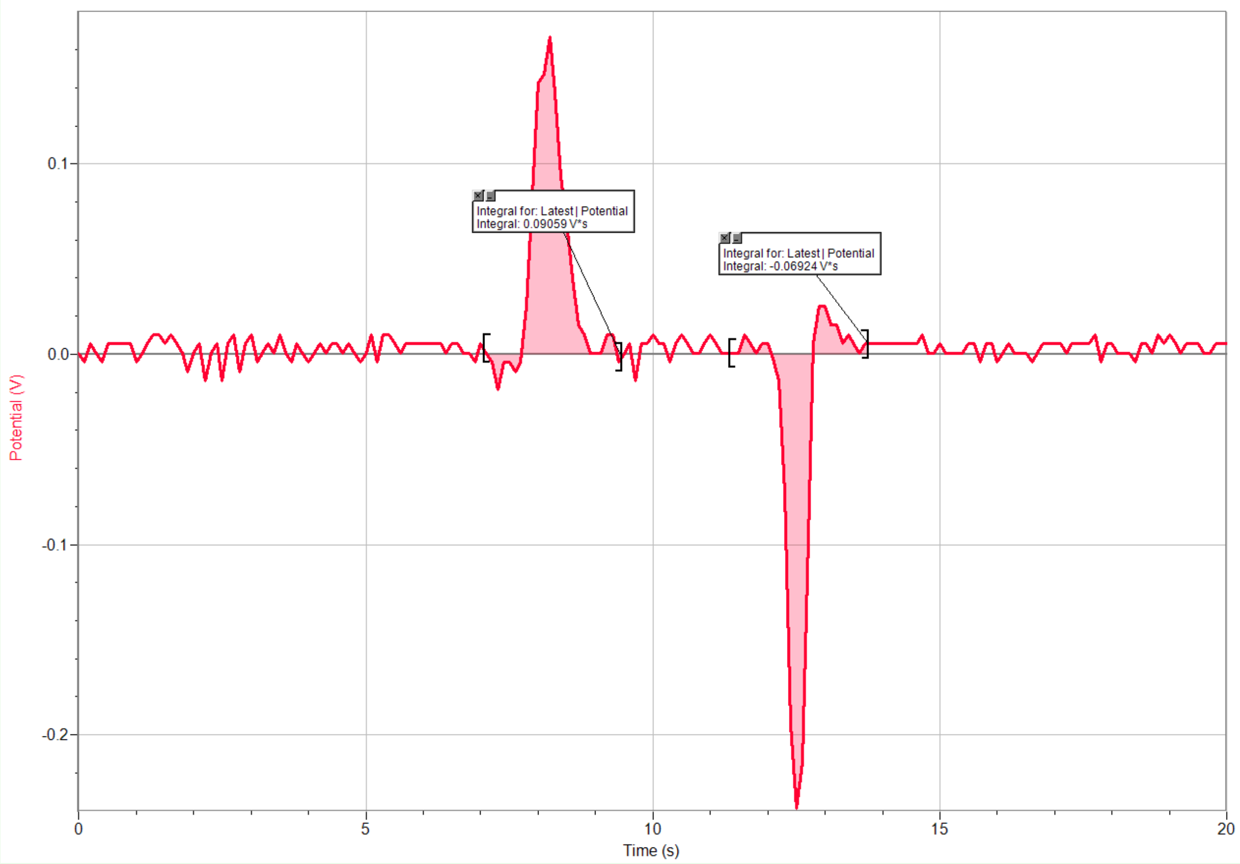
The magnitude changes with speed as only the integral is conserved. Spreading out the integral over time will decrease its magnitude in order to preserve the integral.

The integrals should be the same as they start and end at the same points. They are roughly similar in magnitude to each other, but they are slightly different due to error in integration and human error.

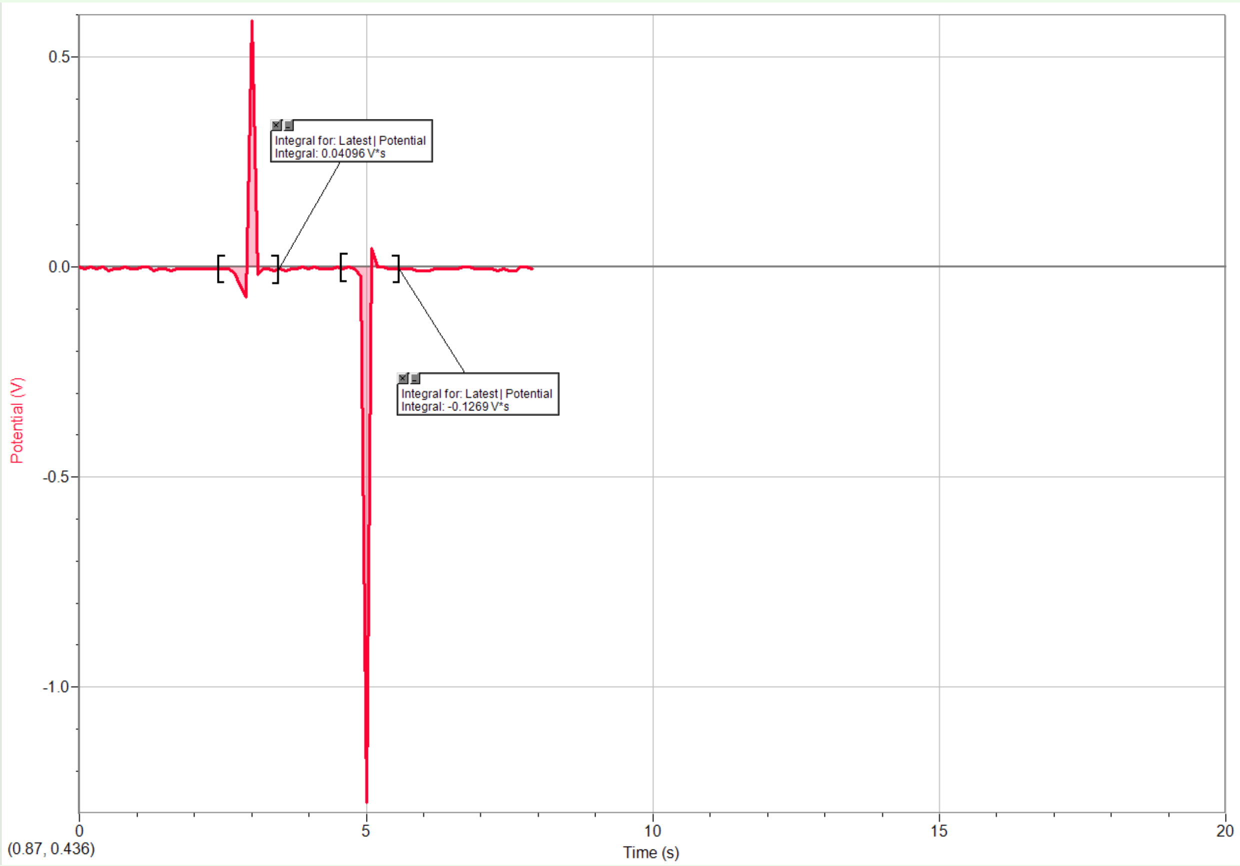
Normal:



Slow:


Integral for: Latest | Potential
Integral: 0.09059 V*s
Integral for: Latest | Potential
Integral: -0.06924 V*s
Potential (V)
Time (s)
0.1
0.0
-0.1
-0.2
0
5
10
15
20

Fast:


Integral for: Latest | Potential
Integral: 0.04096 V*s
Integral for: Latest | Potential
Integral: -0.1269 V*s
Potential (V)
Time (s)
0.5
0.0
-0.5
-1.0
0
5
10
15
20
(0.87, 0.436)

v

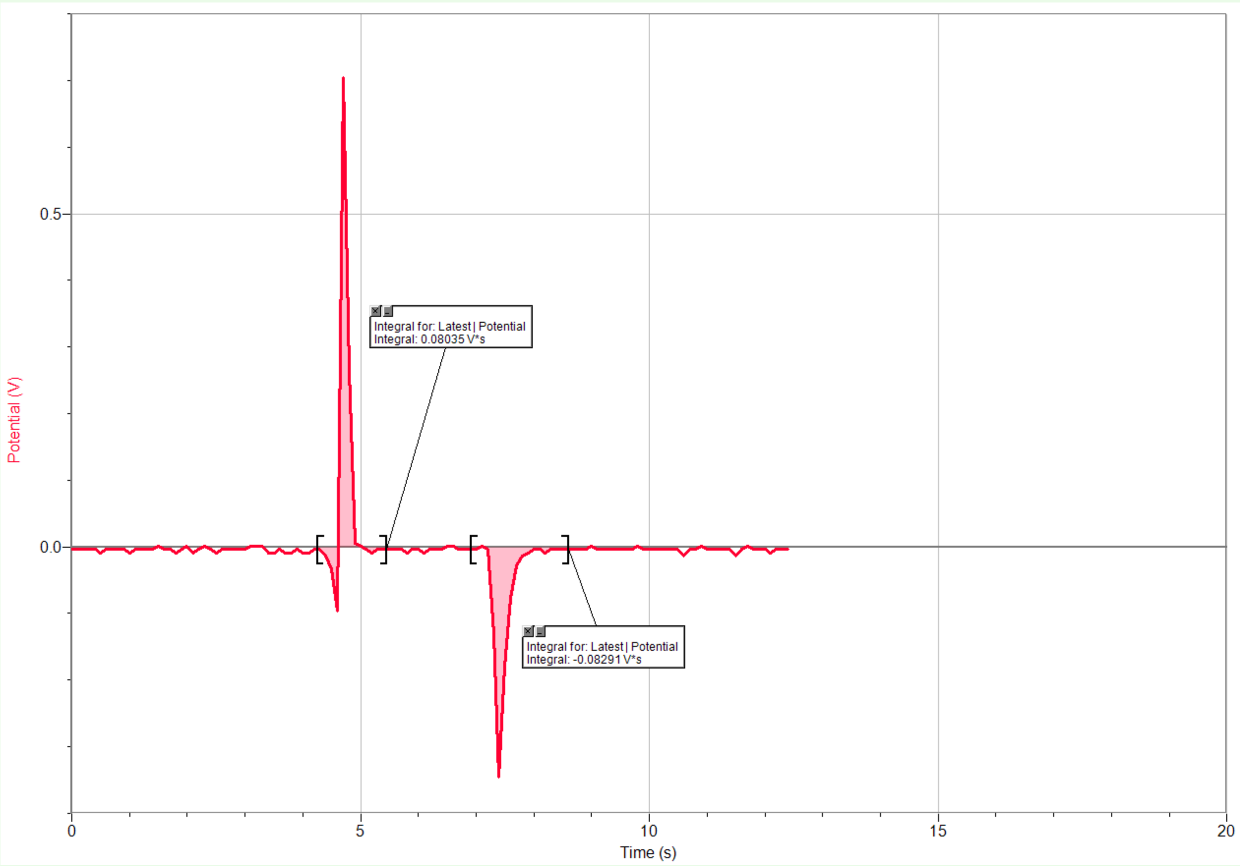
Record the values of the integrals for
Moving the coil onto the magnet, lifting it up and back

Are these values equal but opposite? Is this behavior expected? Explain why or why not.

✓ **Answer**

Onto: $0.08035\ Vs$
Up: $-0.0829\ Vs$

This is expected, as the path does not matter, only the start and end points do.



2

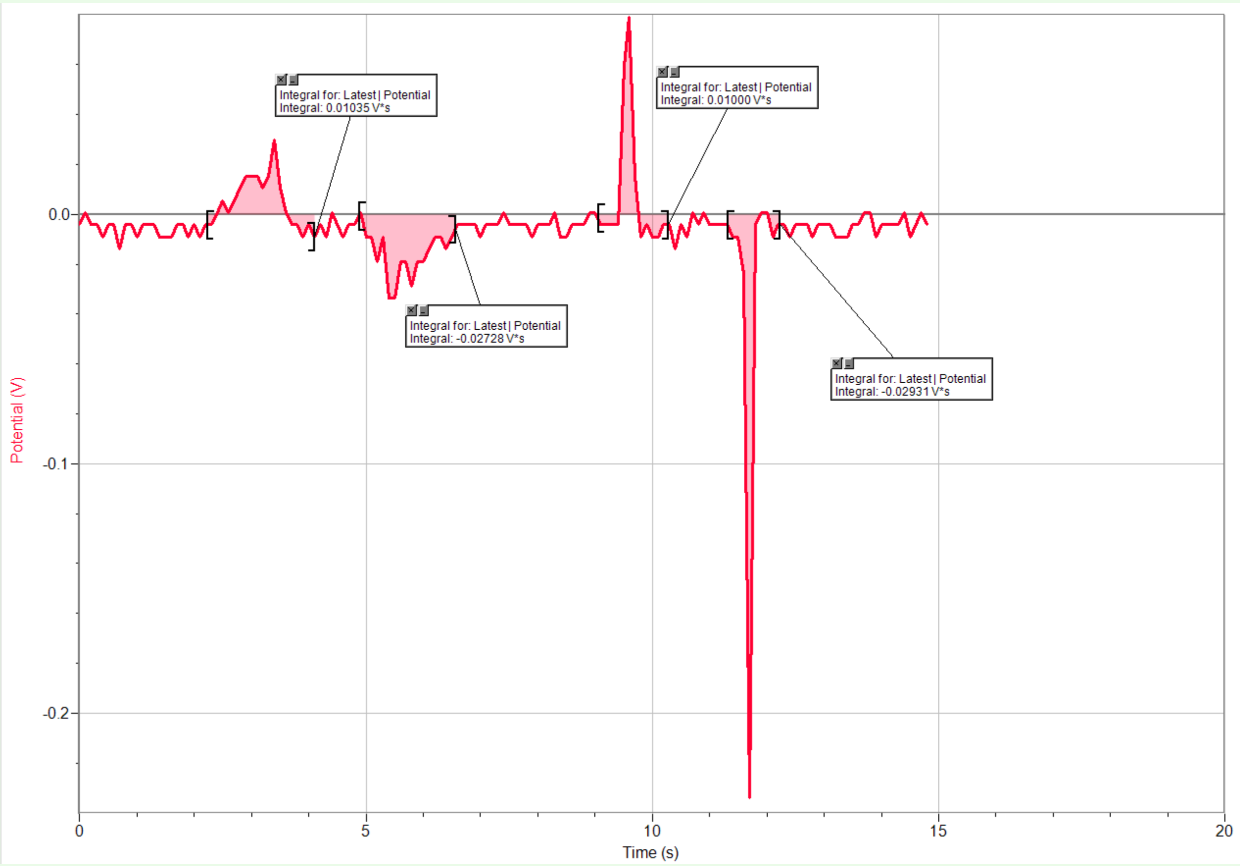
For section D.3 with rotating coils: (Attach a copy of the printout as requested.)
Record the values of the integrated areas for the 90º flips? (average of two values)
Fast, Slow

Record the average time integral for your four 180° flips
Determine the strength of the magnet from these flips

✓ **Answer**

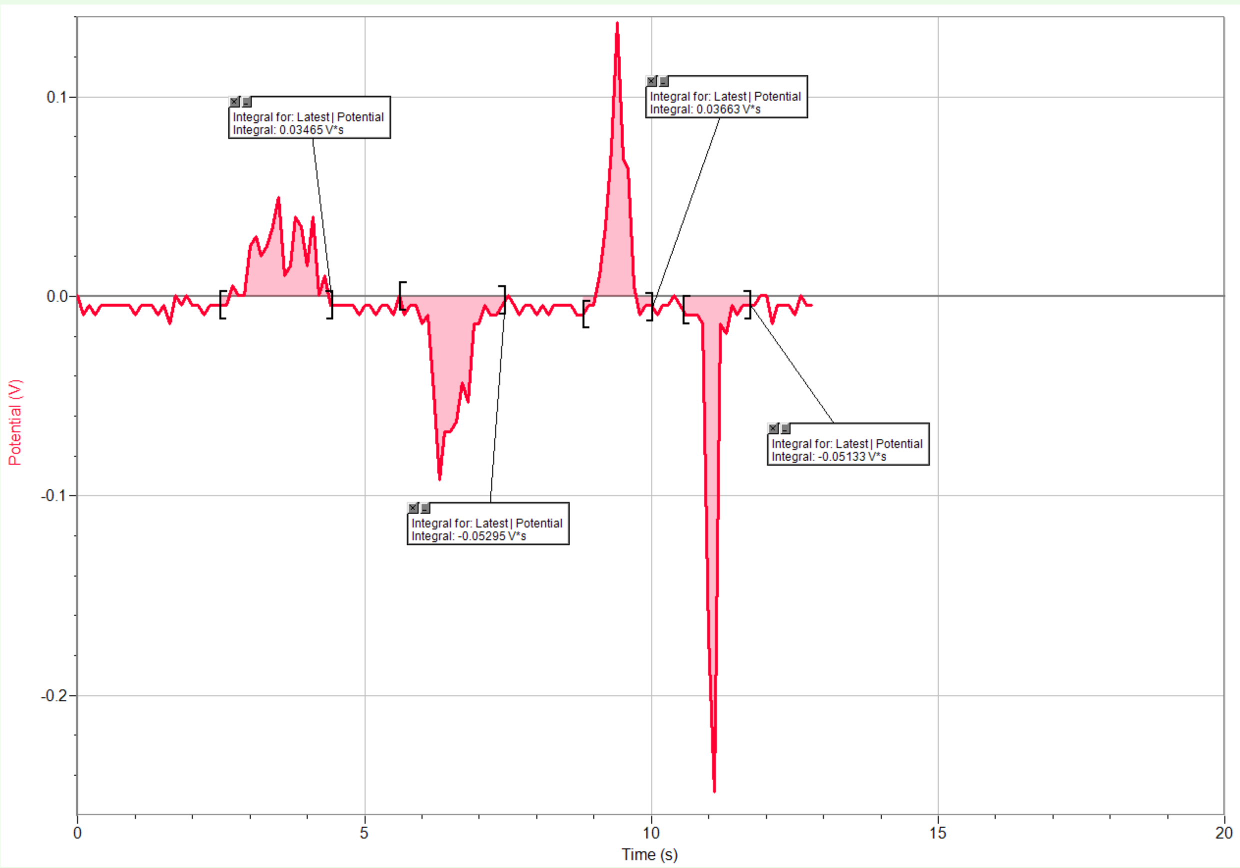
90°:
Slow: $0.018815\ Vs$

Fast: $0.019655\ Vs$



180°:

$0.04289\ Vs$



$0.04289 = BA$

$\frac{0.04289\ kg\ m^2\ s^{-2}\ A^{-1}}{1600(0.000077)\ m^2} = B$

$B = 0.35625\ T$

$\square$

3

Section D.4 - Coupled circuits

Explain the shape of the induced waveform in relation to the input waveform.
What are the EMFs for the coils with different number of turns at 20Hz?

16 turn, 160 turn, 1600 turn

Compare this behavior to theory.

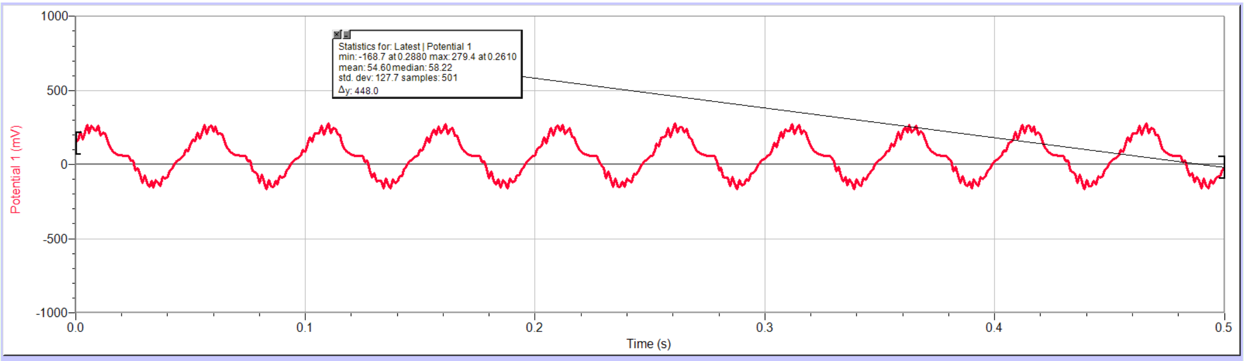
✓ **Answer**

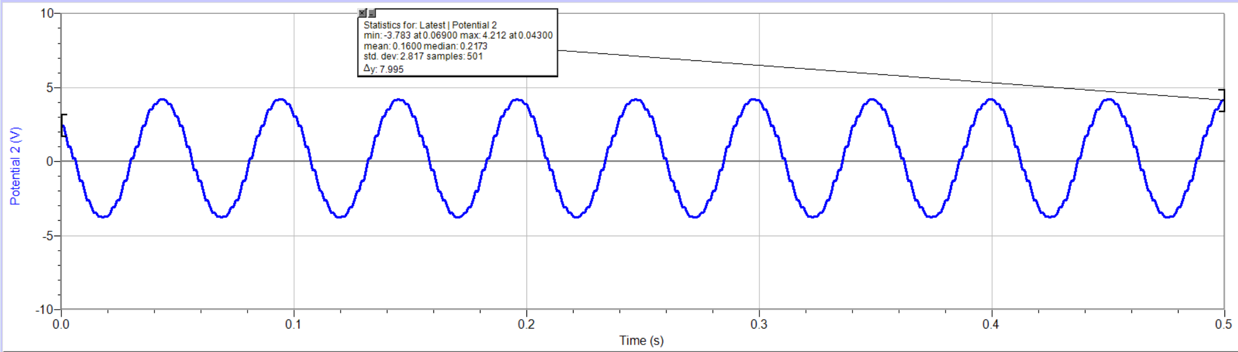
For the sine waves, the inputs and outputs looked very similar.
For square waves, the output looked like a square wave but each peak died off faster than the input.

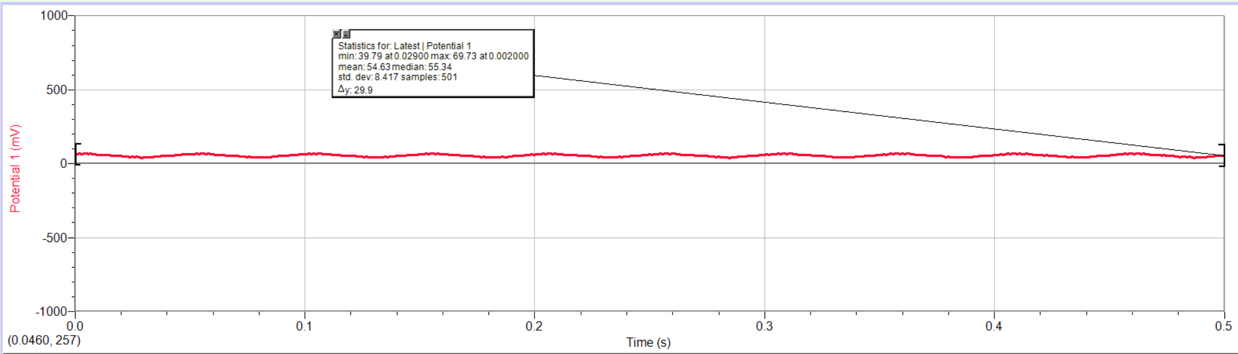
For our 16, 160, 1600 turn tests we obtained:

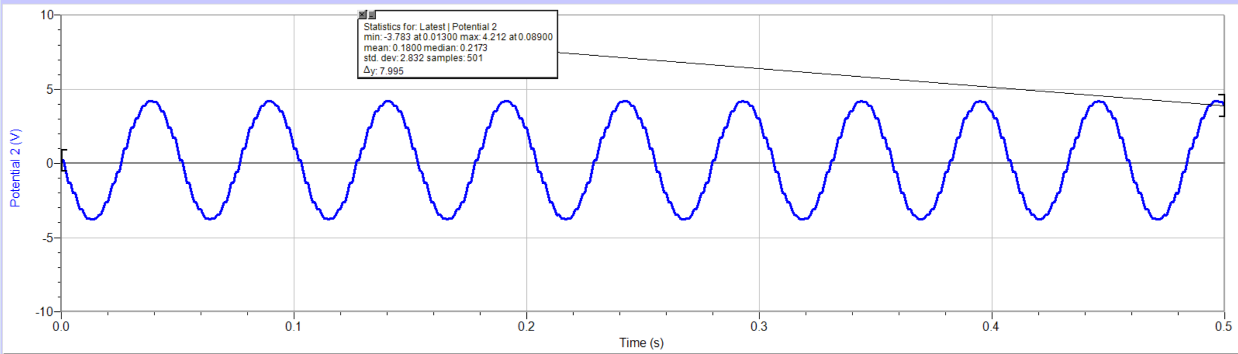
Turns	Voltage
16	$224.05\ mV$
160	$14.97\ mV$
1600	$1.73\ mV$

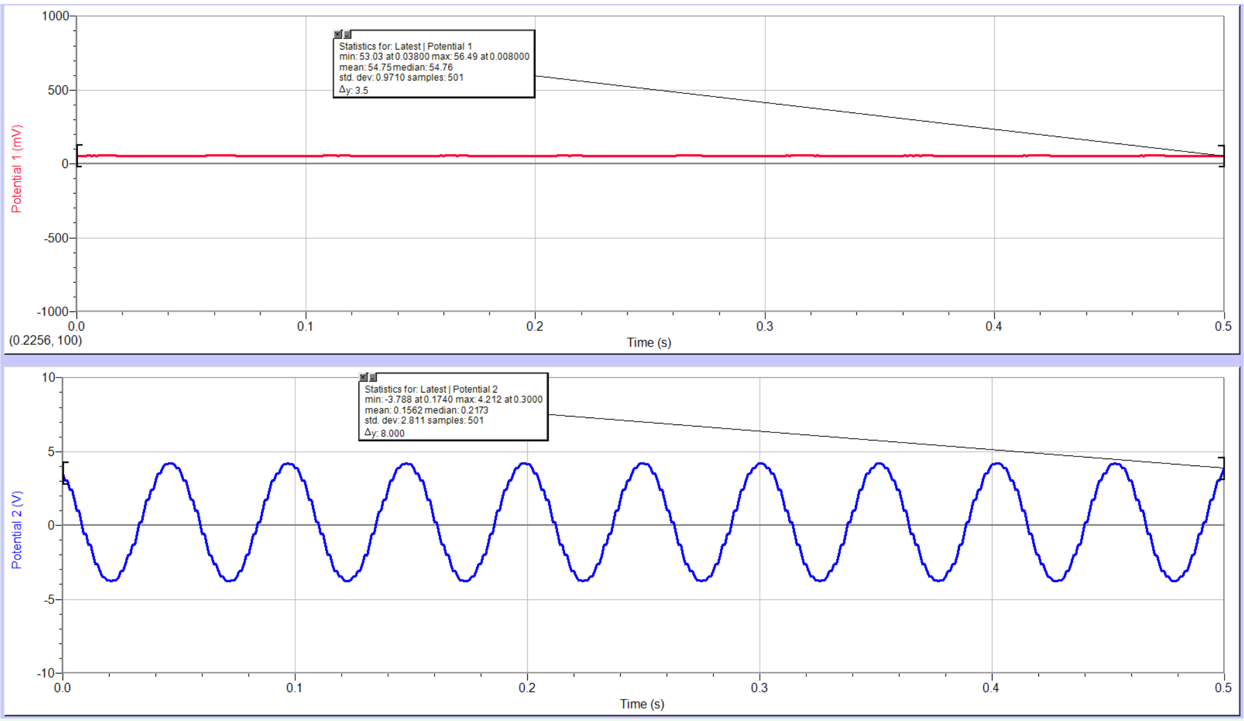
This is in line with theory as the voltage is proportional with cross section area and number of turns, so as the number of turns increase the induced voltage also increases.


Statistics for: Latest | Potential 1
min: -168.7 at 0.2880 max: 279.4 at 0.2610
mean: 54.60 median: 58.22
std. dev: 127.7 samples: 501
Δy: 448.0
Potential 1 (mV)
Time (s)


Statistics for: Latest | Potential 2
min: -3.783 at 0.06900 max: 4.212 at 0.04300
mean: 0.1600 median: 0.2173
std. dev: 2.817 samples: 501
Δy: 7.995
Potential 2 (V)
Time (s)


Statistics for: Latest | Potential 1
min: 39.79 at 0.02900 max: 69.73 at 0.002000
mean: 54.63 median: 55.34
std. dev: 8.417 samples: 501
Δy: 29.9
Potential 1 (mV)
Time (s)
(0.0460, 257)


Statistics for: Latest | Potential 2
min: -3.783 at 0.01300 max: 4.212 at 0.08900
mean: 0.1800 median: 0.2173
std. dev: 2.832 samples: 501
Δy: 7.995
Potential 2 (V)
Time (s)


Statistics for: Latest | Potential 1
min: 53.03 at 0.03800 max: 56.49 at 0.008000
mean: 54.75 median: 54.76
std. dev: 0.9710 samples: 501
Δy: 3.5
Potential 1 (mV)
Time (s)
(0.2256, 100)
Statistics for: Latest | Potential 2
min: -3.788 at 0.1740 max: 4.212 at 0.3000
mean: 0.1562 median: 0.2173
std. dev: 2.811 samples: 501
Δy: 8.000
Potential 2 (V)
Time (s)