ONLINE LABS: USING VIDEOS, SPREADSHEETS, AND ONLINE QUIZZES, OH MY!

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IN-CLASS LAB STRUCTURE

Students groups of 4

Lab time frame 1 hr 50 minutes
students turn in papers at end of lab period

No formal pre-or post- lab

Lab Writeup Structure:
- Introduction
- Step-by-step procedure
- Data sheets with analysis and questions
FRIDAY, MARCH 13: “WE’RE GOING ONLINE”

• PHET Simulations?
• IOLab?
• Cellphone based labs?
• Live lab with faculty?

One does not simply teach Physics labs online...
SAVING INTRO PHYSICS LABS...

• Use existing lab manual and equipment
• Collect data for students
• Use video vignettes
  • show students equipment
  • scale markings and “pitfalls”
  • perform trials for each part of experiment
• Students provided data to “complete” lab
SECOND SEMESTER INTRO LABS

Jennifer: Algebra-based physics
- Mainly biology and pre-med but some chemistry, cs, geoscience, & math majors

Ignacio: Calculus-based physics
- Mainly physics & engineering allied majors

Labs identical
- Calculus-based – more challenging extension questions
Students required to:
- Fill out lab manual sheets
- Scan into pdf for BB upload

Faculty uploads & grade 24 pdfs per lab

Excel spreadsheets replace lab sheet analysis

Quizzes online replace lab questions
THE ONLINE "LAB" EXPERIENCE

- Read lab
- Watch videos
- Complete data analysis on pre-made spreadsheet

Blackboard “Quiz” Structure:

- FILE RESPONSE for Excel Spreadsheet (4-5 pts)
- Questions:
  - Observation questions
  - Experimental Uncertainties
  - Conceptual extensions (Roughly 0.5 pts each)
BLACKBOARD VIEW OF LAB MATERIALS

Lab #9 Earth’s B-Field
Attached Files:
- Lab_9_Part_1.mp4 (60.949 MB)
- Lab_9_Part_2.mp4 (29.775 MB)
- Lab_9_Phys202_Student_Sheet.xlsx (10.57 KB)
- Data for Physics 202 Lab 9.pdf (265.459 KB)

Attached are the items needed for Lab #9. You should use your lab manual you purchased - read the background and procedure carefully.

Lab #9 Earth’s B-field
Availability: Item is no longer available. It was last available on Apr 5, 2020 11:59 PM.
Earth's Magnetic Field Virtual Lab
Laboratory #9: Earth’s Magnetic Field
Data Sheet & Questions

NOTE: Items in blue are measured values.

Radius of Coil, R (include units) = \( \frac{1}{2} \times 5\text{cm} \times \frac{1}{2} \times 5\text{cm} \). NOTE: The diameter was measured using a standard ruler with markings of 1 mm being the smallest interval. We estimate an uncertainty of \( \pm 0.2\text{mm} \) for the measured diameter.

<table>
<thead>
<tr>
<th>Table 1: Compass Deflection as a Function of Coil Current</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coil Current (A)</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>( N = 5 )</td>
</tr>
<tr>
<td>( I_1 = 0.207 )</td>
</tr>
<tr>
<td>( I_2 = 0.325 )</td>
</tr>
<tr>
<td>( I_3 = 0.397 )</td>
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<tr>
<td>( N = 10 )</td>
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<tr>
<td>( I_4 = 0.132 )</td>
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<tr>
<td>( I_5 = 0.210 )</td>
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<tr>
<td>( I_6 = 0.295 )</td>
</tr>
<tr>
<td>( N = 15 )</td>
</tr>
<tr>
<td>( I_7 = 0.086 )</td>
</tr>
<tr>
<td>( I_8 = 0.142 )</td>
</tr>
<tr>
<td>( I_9 = 0.236 )</td>
</tr>
</tbody>
</table>

Average \( B_s = \) T

\% Difference [Between your result and accepted value]: 

Question: What is the most significant source of measurement uncertainty in this experiment?
SAMPLE OF PRE-BUILT SPREADSHEET

<table>
<thead>
<tr>
<th>N</th>
<th>Theta</th>
<th>Theta (radians)</th>
<th>tangent</th>
<th>( \theta )h</th>
<th>( \theta )</th>
<th>B_h</th>
<th>Average</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>0.524</td>
<td>0.207</td>
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<td>40</td>
<td>0.698</td>
<td>0.325</td>
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<tr>
<td>4</td>
<td>50</td>
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<td>0.397</td>
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<td>11</td>
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<td>0.236</td>
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</tbody>
</table>

- Fill in the highlighted boxes by using equations calling on values in Cells A11, A12, and where appropriate A2, A3, and A9. Remember that to fix a cell value you can use A11s, A$19, etc. Make sure you use appropriate sig figs!

- Recall that MS Excel trig functions require angles in radians, use column C for computing values in column D.
LESSONS LEARNED

- Students struggled with
  - Using Excel as a calculator
  - Controlling numerical output
  - Knowing/Using trigonometric functions

- Converting existing open-ended questions
  - not necessarily trivial
  - takes time on front end

- Periodically, faculty need to do the labs – quality control!
THOUGHTS ON FUTURE

• Excel neglected tool in our intro labs – needs to be remedied

• Videos vignettes – Opportunity for Pre-labs?
THANK YOU!

Any questions?
QUESTION 1

Using the data provided in the pdf file, please fill out the attached spreadsheet. You will need to create formulas to calculate $B_h$ for each current reading referencing the cell values for the appropriate $N$ and $I$ and using the values the radius and the constant $\mu_0$.

You should calculate the average value of all nine individual $B$ values and then the percent difference between the known value of $B_h$ in Morehead, KY (found in your lab manual).

Answer all of the questions. There is only one correct answer for each.

You will receive
2 points for correctly calculated values for $B_h$ and its average
1 point for correctly calculated % difference
1 point for correct use of significant digits

Attach File
For each situation, determine if the experimental uncertainty introduces a random uncertainty or a systematic uncertainty. Use R for random and S for systematic.

1. A student measures the diameter of the current carrying coil and reports it on the data sheet instead of dividing by two. 

2. A student measures the diameter of the current carrying coil with a standard ruler with a precision of +/- 1 mm. 

3. A student measures the angles on the compass and estimates that is it at each desired angle. 

4. A student lines up their coil on the N-S line but knocks the compass so that the angle with no current on is at 5 degrees instead of zero degrees. 

5. The measured currents that the student records from the DMM are good to +/- 0.7%. 

6. A student places their cellphone, which contains magnets for various functions, on the right side of the tangent galvanometer while performing the experiment.
In video 2, when we reverse the leads on the power supply, you observed that the angular deflection is reversed. Which of the following is the best explanation for this phenomenon?

- [ ] a. The current in the loop is reversed which changes the magnetic poles of the compass needle.
- [ ] b. The voltage in the loop is reversed and this reverses the magnetic poles on the compass.
- [ ] c. The current through the loop is reversed. This reverses the direction of the magnetic field of the loop resulting in a force on the compass needle that is the opposite to the direction of the force in the original setup.
- [ ] d. None of these correctly explains the phenomenon.
“EXTENSION” QUESTION

QUESTION 7

What would you expect for the dip angle at the equator?

- a. 0°
- b. 45°
- c. 90°
- d. 180°