Electronic Laboratory Notebooks in the Advanced Undergraduate Laboratories

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- Approximately 100 Undergraduate Chemistry Majors
- Majority go into Health Sciences – Remainder to Graduate School or Industry
- Approximately 60-80 Ph.D. Students
The Challenge:

- To maintain a state-of-the-art teaching environment reflecting changing trends in academic and industrial laboratories
- To prepare students for future work in professional, academic and industrial settings
Computers in the Teaching Lab

- Over the past decade...

Instrument Control  Stand-Alone Computers  Data Collection & Numerical Analysis
Computers in the Teaching Lab

Networked Computers

- Report Writing
- Data Collection & Numerical Analysis
- Literature Search
- Instrument Control
The Latest Addition

- Beginning in 2001...

- Instrument Control
- Reports
- Literature Search
- Data Collection & Numerical Analysis
- Networked Computers
- Electronic Lab Notebooks (ELN)
Requirements of an ELN

- Secure, “write-once” structure
- Accessible during and after lab hours
- User friendly
- Affordable
- Collaborative
Advantages:

- Files are submitted with time and date stamp - cannot be overwritten
- Internet Accessible
- Familiar to students
- Provides a collaborative environment within a password protected frame
Disadvantages:

- Difficult for large classes with multiple sections and multiple instructors
- Is only a host - notebook files created with third party software
Construction of a Lab Notebook

- Document files created with Word
- Equations and calculations created with equation editors, math programs or scanned images
- Graphs, pictures and chemical equations imported into the text
Data Collection:

February 20, 2002
Combustion of sucrose.

To be sure that the bomb calorimeter is working properly now, and to make sure has data from yesterday’s experiment, I will do two combustions of sucrose.

Trial 1:
Mass sucrose before making the pellet = 0.9840 g
Mass of sucrose pellet = 0.9834 g
Mass of use wire = 0.0153 g

Uncertainty in each mass measurement = ±0.0002 g

Set up bomb and begin run – filename twuxx.dat
2000.0±0.5 mL water added to the calorimeter to record temp change.

Pellet clearly ignited. It appeared that temp rise was slow – but I will look at this.
Data Analysis:

MAKE SURE THE PRINTER IS READY

Press any key to continue

Pellet clearly ignited. It appeared that temp rise was slow - but I will the data to see for sure. Graph is shown below for t2wcr1.dat. The looks fine after all!

Mass of unburned fuse wire = 0.0130 g
Literature Search:

Data compiled by: H.Y. Afeefy, J.F. Liebman, and S.E. Stein

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Value</th>
<th>Units</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta H^\circ$</td>
<td>-5643.4 ± 1.8</td>
<td>kJ/mol</td>
<td>Ceb</td>
<td>Ponomarev and Migarskaya, 1960</td>
</tr>
</tbody>
</table>

Mass of unburned fuse wire = 0.0130 g
In the Paperless Laboratory
Uploading Notebook File:

Pellet clearly ignited. It appeared that temp rise was slow—but I will check the data to see for sure. Graph is shown below for twsuc1.dat. The looks fine afterall!

Mass of unburned fuse wire = 0.0130 g

Literature value for the heat of combustion is -5643.4 ± 1.8 (Ponoma...
“Store” or “Send”

Digital Drop Box

Expt 4 calorimetry thermo gram pages
Submitted by: Richard Ariaga (ra18)
Received on: 2005-02-09 2:19:37 PM
Comments: bomb11.jpg and bomb21.jpg contain graphs for the benzoic acid

bomb31.jpg and bomb41.jpg contain graphs for the sucrose octaacetate sample

Expt 4 calcs
Submitted by: Richard Ariaga (ra18)
Received on: 2005-02-07 1:24:46 PM

Expt 4 Bomb Calorimetry Notebook page
Submitted by: Richard Ariaga (ra18)
Received on: 2005-01-27 2:39:44 PM
Comments: Raw data for expt 4 by Richard Arriaga.
Or, For Better Organization…

Assignments

Experiment #1 - Beer’s Law Prelab

Please complete the prelab assignment found on page 31 of your lab manual. *before your lab section.* Instructions on how to submit your work is found on page...

**Gradebook View**

<table>
<thead>
<tr>
<th>Name (Last, First)</th>
<th>Experiment #1 - Beer’s Law Prelab</th>
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<tbody>
<tr>
<td></td>
<td>Assignment</td>
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<tr>
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<td>Pts Possible 5</td>
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<td>Weight 0%</td>
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<td>Barrett, Kyle</td>
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<td>Hall, Molly</td>
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<td>Joshi, Shawn</td>
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<td>Kesler, William</td>
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</table>
Many enjoy the paperless laboratory

Electronic Lab Notebooks (ELN)

Instrument Control

Data Collection & Numerical Analysis

Networked Computers

Reports

Literature Search
The Upside?

- The **pre-laboratory** work using the ELN works very well
  - Quick, easy, electronic communication between students and instructors
  - Discussion Boards, File-Sharing Groups, Virtual Classrooms and Office Hours (Chat-style sessions) all available through Blackboard
The Upside?

- Convenient
  - All lab operations at a single computer

- Collaborative
  - Instructors share data and information
  - Students and Instructors communicate

- Secure
  - Password protection
  - Overwrite protection
  - Only Managers can remove files
The Downside?

- The time consuming task of typing mathematics
- Many programs running simultaneously
- Can be a nightmare of file-type manipulations
From My Perspective:

- The ELN is the right move - it will only get easier, faster, better with time.
- But, We are not yet ready to eliminate paper notebooks
  - Computers are not in all the teaching labs
  - Industry has not completely moved away from paper
Acknowledgements

- Duke University Center for Instructional Technology for funding and support for this project.

- The many students and teaching assistants that continue to use and improve our ELN.