

Paperless Physics Laboratory Course Using the Blackboard Resources



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University of Alberta

1. Introduction. A hand-written informal lab report in a notebook.

The author was teaching and coordinating physics UG labs in 2002 – 2015 for students of Physics Specialist, Physics Major and Engineering Science programmes.

Requirements to an *informal* report in a lab notebook :

Answers to preparatory questions and a statement of **!!!** the experiment goals checked by a TA before a session .

Complete step-by-step record of all lab activities **OK**

Tables of measurements and calculated quantities **!!!**

Graphical presentation of experiment results **!!!**

Data analysis, error calculation, conclusion **OK**

1. Introduction. A hand-written informal lab report in a notebook.

What was a typical length of a paper lab report allowed to submit several days after a session? – 16 – 20 pages.

How long on average did it take a student to write a good lab report according to surveys among students? – > 10 hours.

How did the students start using modern technologies to help themselves in the report preparation? –

Students started recording the procedure with their laptops; typing and printing out tables, graphs and voluminous parts of the text then attaching the printouts to pages of the notebook; making and printing out error calculations with on-line formula editors.

Students' innovations were welcomed by TAs/Markers.

2. Main goals of a pilot project started in 2013 for the 1st and 2nd year Engineering Science students

Expected impact on students:

- Reducing students' time for a laboratory report preparation efficiently utilizing their computer literacy and typing skills.
- Incorporating computer generated graphs and diagrams into the text of the report.
- Teaching students specific skills in organization of an electronic document.
- Simplifying submission of the report (from anywhere at any time) by uploading the report to Blackboard (BB).
- Increasing work space by a laboratory setup.
- Combining uploading the report to BB for marking with submitting same report to the Turnitin.com.

2. Main goals of a pilot project started in 2013 for the 1st and 2nd year Engineering Science students

Expected impact on instructors:

- Eliminating misreading of unlegible report.
- Creating more universal marking scheme using the BB rubrics, simple and clear for students and Markers.
- Simplifying access to the report (from anywhere).
- Simplifying a TA's/Marker's substitution (the TA's absence, request for remarking, strike, etc.).
- Making the report available for reviewing by a course coordinator at any stage of marking and after.
- Providing a secure, accessible by an instructor and long-lasting storage of marked lab reports in electronic repository on Blackboard.
- Reducing paper consumption.

This is a Green Course!



Your instructor has committed to reducing this course's environmental impact.

sustainability.utoronto.ca #greenerUofT

3. Organization of the course on BB.

- For each experiment, a course coordinator prepares an Assignment on BB with a template of a lab report.
- The course coordinator prepares a Test with preparatory questions in the multiple choice format. The test is taken before the session and the mark is assigned immediately on Blackboard in My Grades (as for any test).
- Students prepare a lab report in PDF or Word.
- Students upload the report to a corresponding Assignment before a deadline.
- A Marker downloads the report, enters comments into the text, uploads the marked report back to BB and ticks applicable details of rubric online.
- The marker enters the mark to the Grade Center.
- The TAs upload graded reports to the Course Content.

4. Some data from surveys and feedback

Students (508 surveyed in three courses in 2013, 2014, 2015)

1. Compared to other courses that require a hard copy of the lab report, is electronic format of the Physics lab report more convenient?

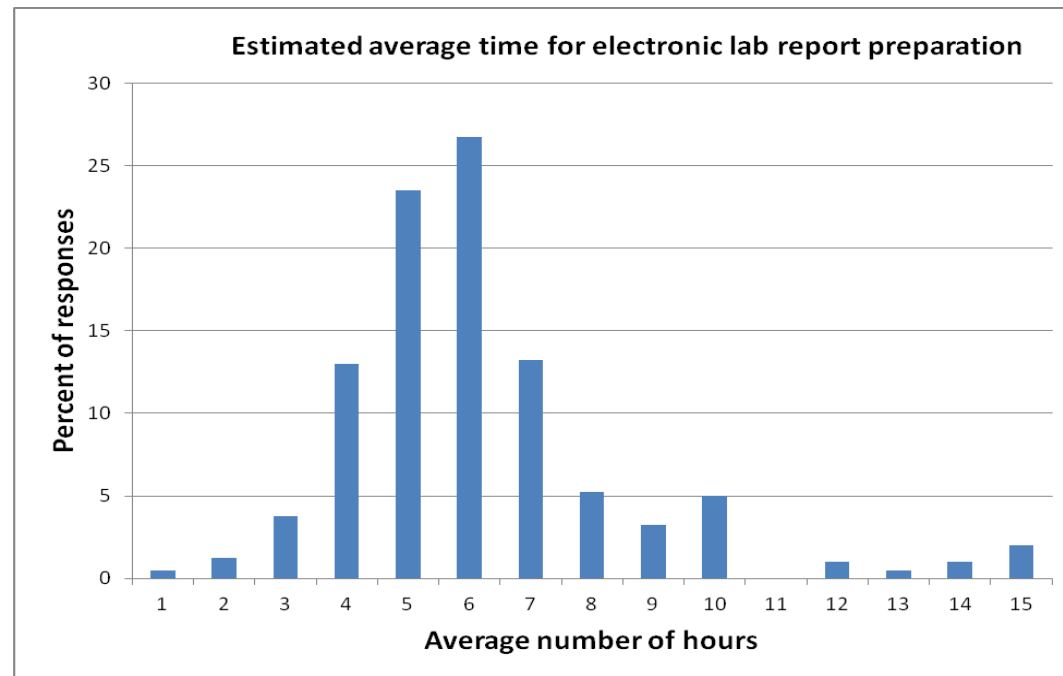
YES - 97 - 99% of a class

2. Were you satisfied with the TA's feedback in electronic format?

YES - 82 - 94% of a class

3. How long did it take you to write a final version of electronic report?

Compare to a mode at 10 - 16 hours indicated by students of same courses surveyed before 2013.



4. Some data from surveys and feedback

TAs (28 responses; teaching in three courses)

- Why do you like electronic reports?

- No problems with heavy piles of notebooks that can be graded only at the department - 100%.
- Easy readable and legible text - 100%.

- Why don't you like electronic reports?

Used to give hand-written comments - 50%

- Report in which format - paper or electronic - you marked quicker for same experiment in this lab course?

Paper - 50%; electronic - 7%; same time - 43%

- Both the students and the TAs voted solid for a marking scheme based on the BB rubrics.

4. Some data from surveys and feedback

Technical Lab Assistants:

- In addition to reduced paper use, students are less hurried to finish work on time and are actually finishing labs on time.
- I believe that students type faster than recording with a pen. Importing data and images electronically is quicker and more accurate than manually copying and printing.

Course Coordinator (me)

- Easy access to all submitted and graded reports.
- Simple organization of reports' storage for years.
- Cases of copying/plagiarism were eliminated by simultaneous submission of the reports to BB and turnitin.com.

5. Sources of information on electronic laboratory notebook (ELN) in Physics labs

1. University of Pennsylvania. Department of Physics and Astronomy UG Physics Labs Spring 2013
<https://www.physics.upenn.edu/undergraduate/undergraduate-physics-labs>
2. Cornell University Pilot project
http://events.cornell.edu/event/electronic_lab_notebook_demonstration
3. University of California at Berkeley: Physics 111 (Advanced Physics Lab)
http://www.advancedlab.org/mediawiki/index.php/Advanced_Syllabus
4. Lots of sites with promotions of commercially available software under the title “ELN”.

APPENDIX. Reports submission and marking.

The screenshot displays a Blackboard course interface. On the left is a navigation menu with the following items: Home Page, Announcements, Syllabus, Course Materials, Discussion Board, Tools, My Grades, Contacts, Library Resources, and About Your Course. Below this is a 'COURSE MANAGEMENT' section with a 'Control Panel' containing links for Content, Course Tools, Evaluation, Grade Center, Users and Groups, Customization, Packages and Utilities, and Help.

The main content area is titled 'Course Materials' and features a dark navigation bar with 'Build Content', 'Assessments', 'Tools', 'Partner Content', and 'Discover Content'. The 'Assessments' section is active, showing an 'Exercise' assignment with an attached file 'Exercise.doc' (103.5 KB). The assignment instructions state: 'Download a template, attached to this assignment. Your report must be complete. Answer all questions where required. You will need to calculate an error of different functions not measured directly. Use the rules of error propagation. To submit the lab report for marking, make sure that your file name includes information about you, your experiment and contains only letters and numbers, e.g. Exercise by Brian Wilson and Peter Krieger or Experiment 1 Microwaves by Hoi-Kwong Lo and Natalia Krasnopolskaia. Your file must be submitted in the format of Word document to allow a marker making comments and corrections to your text. Do not attach multiple files with same name. On the BB your lab report will be called an Assignment.'

A list of instructions follows:

- To upload your report as an Assignment, click on the appropriate link in the Course Menu.
- Click on the title of the Assignment
- Click Browse for local File on your personal computer. Locate your file.
- Once you see the file listed in the BB window, click the Attach File button
- Click Open
- Click Submit
- You are allowed two attempts. After you click Submit 2nd time, you cannot alter your submission any more. You also cannot re-submit the report after a marker has started grading paper. Watch the deadlines!

Additional instructions: 'If your submission is impossible due to problems with Portal access, ask an experiment supervisor a permission to send your report via e-mail. Instruction on submission assignments are here: <http://portalinfo.utoronto.ca/content/submitted-assignments>.'

Below the 'Exercise' are two 'Experiment' assignments, each with an attached file 'Experiment 1.doc' and 'Experiment 2.doc' (both 25.5 KB). The 'Experiment 1' assignment includes the instruction: 'See Instruction to the Exercise'.

APPENDIX. Reports submission and marking.

The screenshot displays the Blackboard LMS interface for the course 'Winter-2015-PHY294H1-S-PRA0101 (QUANTUM AND THERMAL PHYSICS)'. The left sidebar contains navigation links such as Home Page, Announcements, Syllabus, and a 'COURSE MANAGEMENT' section with options like Control Panel, Content, and Course Tools. The main content area, titled 'Course Materials', features a top navigation bar with 'Build Content', 'Assessments', 'Tools', 'Partner Content', and 'Discover Content'. Below this, several assignment items are listed, each with an icon and a description:

- Weight 1**: Submit your first one-weight experiment or the first part of your two- or three-weight experiment to this assignment.
- Weight 2**
- Weight 3**
- Weight 4**
- Formal Report**: One of the lab reports, chosen by you, must be submitted in a format of a scientific article. This folder contains useful materials for preparation of the Formal report. The Formal report will be marked as any other lab report in PHY294, and will get additional marks for composition, style and notation.
- Experiment booking**: Enabled: Statistics Tracking. Attached Files: [Bookings in section 1JY 23.03_4 PM.pdf](#) (37.051 KB). Experiments booked for March 25.

APPENDIX. Reports submission and marking.

PORTAL
UNIVERSITY OF TORONTO

My Page Community Course Evals Content

Course Materials > Preview Upload Assignment: Weight 1

Edit Mode is: ON

Preview Upload Assignment: Weight 1

You are previewing the assignment - your submission will not be saved.

Cancel Save Draft **Submit**

ASSIGNMENT INFORMATION

Due Date Tuesday, February 10, 2015 11:59 PM	Points Possible 20 View Rubric
---	---

Submit your first one-weight experiment or the first part of your two- or three-weight experiment to this assignment.

ASSIGNMENT SUBMISSION

Text Submission [Write Submission](#)

Attach File [Browse My Computer](#) [Browse Content Collection](#)

ADD COMMENTS

Comments

APPENDIX. Reports submission and marking.

Grade Center > Grade Details > Grade Assignment: Weight 4

Grade Assignment: Weight 4

Assign a grade and feedback for the current assignment attempt. Override the overall grade for the assignment by typing a grade in the grade field. If multiple attempts for a test have been allowed, a Student's grade is not released until all of the attempts have been graded. Click **Hide User Names** to grade attempts with user names hidden. Click **Show User Names** to display user information. [More Help](#)

Jump to... Hide User Names Refresh

Viewing 2 of 12gradable items

Harris Charron (Attempt 1 of 1)

Exit

Assignment Details

NAME
Weight 4

DUPLICATE
March 31, 2015 11:59 PM

CLASS STATISTICS

Average	Median
15.977	17.5

GRADE
LAST GRADED ATTEMPT /20

ATTEMPT
3/31/15 11:24 PM

GRADE BY RUBRIC /20

RUBRIC Used for Grading

FEEDBACK TO LEARNER

For the toolbar, press ALT+F10 (PC) or ALT+FN+F10 (Mac).

Add Notes

Cancel Save Draft Submit

SUBMISSION
Interferometry Lab.docx

Interferometry Lab.docx

Download

COURSE MANAGEMENT

- Control Panel
- Content
- Course Tools
- Evaluation
- Grade Center
 - Needs Grading
 - Full Grade Center
 - Assignments
 - Tests
- Users and Groups
- Customization
- Packages and Utilities
- Help

APPENDIX. Reports submission and marking.


my Grades

- Contacts
- Library Resources
- About Your Course

COURSE MANAGEMENT

- Control Panel
- Content >
 - Winter-2015-PHY294H1-S-PRA0103
 - Krasnop1 Content
 - All Courses Content
 - All Organizations Content
 - Institution Content
- Basic Search
- Advanced Search

- Course Tools
- Evaluation >
- Grade Center >
 - Needs Grading
 - Full Grade Center
 - Assignments
 - Tests
- Users and Groups
- Customization >
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- Help



Experiment 2 - Charge to Mass Ratio for Electron by Prabu Karthick Parameshwar and Sriram Sundararaman.pdf


GRADE 16 / 20

LAST GRADED ATTEMPT

ATTEMPT 16 / 20

3/31/15 9:12 PM


GRADE BY RUBRIC

[RUBRIC](#) Used for Grading 


FEEDBACK TO LEARNER





File Name

 graded Experiment 2 - Charge to Mass Ratio for Electron by Prabu Karthick Parameshwar and Sriram Sundararaman Mark for removal

formal commented.pdf

 [Add Notes](#)

SUBMISSION

 [Experiment 2 - Charge to Mass Ratio for Electron by Prabu Karthick Parameshwar and Sriram Sundararaman.pdf](#) 

COMMENTS

Prabu Parameshwar
3/31/15 9:12 PM
This is the experiment written in the formal lab report style.

APPENDIX. Reports submission and marking.

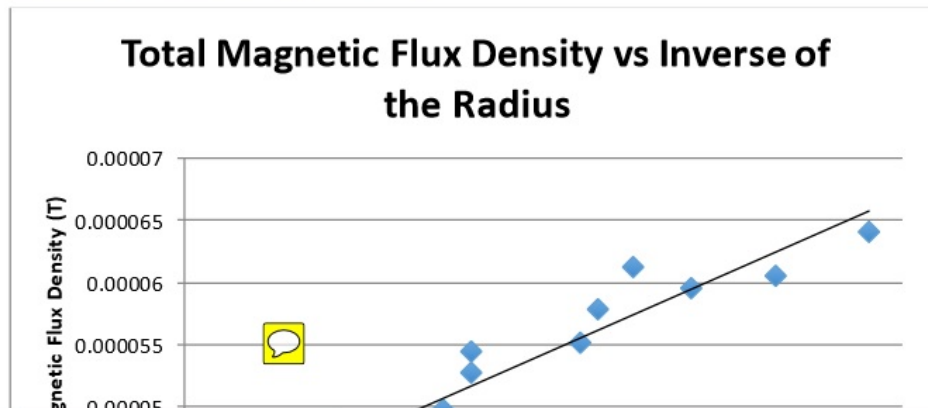
Table 1: This table presents the measured values of the voltages, the magnetic flux density and the charge to mass ratio. There is an uncertainty in the uncertainty was so small that it was deemed negligible.

Chris Granstrom

If that's the case, then your measurement is an infinite number of standard deviations away from the accepted value. Also, it disagrees with your abstract and conclusion (there is an uncertainty there)!

Voltage (V)	Current (mA)	Measured Radius (cm)		
300.8±0.1	201.3±0.1	4.1±0.1		
301.9±0.1	176.9±0.1	4.5±0.1		
301.1±0.1	161.6±0.1	4.8±0.1		
301.8±0.1	151.1±0.1	5.2±0.1		
280.7±0.1	200.2±0.1	3.8±0.1	5.951±0.002 E-5	2.61E+11
280.9±0.1	181.2±0.1	4.1±0.1	5.517±0.002 E-5	2.79E+11
281.2±0.1	164.5±0.1	4.6±0.1	4.974±0.002 E-5	2.81E+11
281.3±0.1	147.0±0.1	5.2±0.1	4.353±0.002 E-5	2.76E+11
320.5±0.1	200.4±0.1	4.0±0.1	6.117±0.002 E-5	2.75E+11
321.6±0.1	178.1±0.1	4.5±0.1	5.439±0.002 E-5	2.81E+11
321.7±0.1	161.3±0.1	5.0±0.1	4.890±0.002 E-5	2.83E+11
322.2±0.1	148.3±0.1	5.5±0.1	4.405±0.002 E-5	2.77E+11
260.2±0.1	206.5±0.1	3.4±0.1	6.403±0.002 E-5	2.82E+11
260.4±0.1	174.0±0.1	3.6±0.1	6.050±0.002 E-5	3.67E+11
260.1±0.1	157.3±0.1	4.6±0.1	4.784±0.002 E-5	2.87E+11
259.6±0.1	140.4±0.1	5.2±0.1	4.182±0.002 E-5	2.83E+11

Graph 1: The following graph plots the total magnetic flux density vs. the inverse of the radius. The y-intercept of the linear fit was used to calculate the magnetic flux from external sources.



APPENDIX. Reports submission and marking.

Experiment:

For (i) the battery and (ii) the DC power supply set to around 6.5V do the following:

- A) Choosing 4 different values of R_L from the box provided, take measurements of the terminal voltage V and the current I . Include an estimate of the uncertainty in these measurements. Organize all data in a table. Provide your notes.

DC Power Source Results (Circuit 2)			
V_{meter} (V)	I_{meter} (mA)	Resistance (Ω)	Resistor Error, $\pm 5\%$ (Ω)
6.35	9.24	680	± 32.5
6.38	7.95	820	± 41.0
6.46	0.770	8200	± 410
6.47	0.190	33000	± 1650

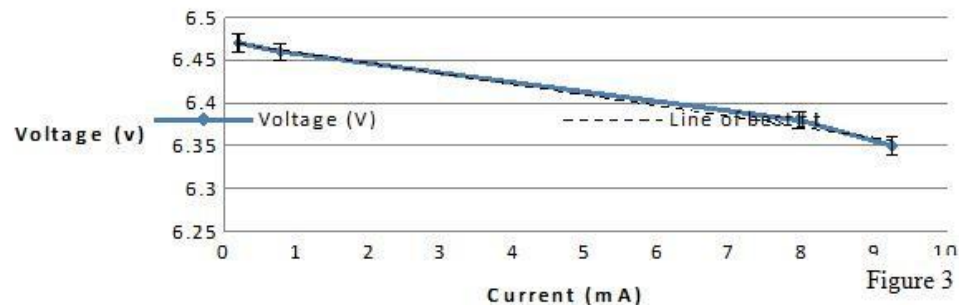
Comment [12]: Complete data for tables but didn't include V and I uncertainties

- B) Using Excel (or any other graphing software), plot the power source, R . Estimate the

Complete data for tables but didn't include V and I uncertainties

Experimental Data and Error Analysis:

I - V Relationship of the DC Power Supply (Cct. 2)



Comment [13]: Good plot. But in the future, don't connect data points that aren't intrinsically connected (i.e. there are no intermediate points, so why pretend data exists there).

Table 2

6.5V Battery Results (Circuit 2)

APPENDIX. Reports submission and marking.

Rubric Detail – Winter-2015-PHY294H1-S-PRA0104 - Mozilla Firefox
https://portal.utoronto.ca/webapps/rubric/do/course/gradeRubric?mode=grid&isPopup=true&rubricCount=1&prefix=viewhist_39448017_1&course_id=_764106_1&maxValue=20.0&r

Rubric Detail

Select **Grid View** or **List View** to change the rubric's layout. [More Help](#)






Name: **Rubric**

Description: **The rubric is directly applicable to a two-weight experiment with a total score of 40. The total score assigned for a one-weight experiment should be divided into two.**

Exit

Grid View

List View

	Novice	Competent	Proficient
Introduction	0 (0%) The physics and background information required to understand the experiment are not well explained.	.5 (2.5%) Some physics and background information required to understand the experiment are not well explained.	 1 (5%) The physics and background information required to understand the experiment are well explained.
Procedure and data	0 (0%) The description of the apparatus is missing.	.5 (2.5%) The description of the apparatus is incomplete.	 1 (5%) The description of the apparatus is present and clear.
Procedure and data	0 (0%) The experiment description is missing or incomplete.	1 (5%) The experiment description is present but insufficient to reproduce.	 2 (10%) There is a clear description of the experiment procedure.
Procedure and data	0 (0%) No raw data included.	 .5 (2.5%) Raw data is insufficiently presented.	1 (5%) Raw data is clearly recorded.
Procedure and Data	0 (0%) Units and significant figures on raw data missing or incorrect.	.5 (2.5%) Some units and significant figures on raw data missing or	 1 (5%) Units and significant figures

APPENDIX. Reports submission and marking.

My Grades

- Contacts
- Library Resources
- About Your Course

COURSE MANAGEMENT

Control Panel

Content

- Winter-2015-PHY294H1-S-PRA0103
- Krasnop1 Content
- All Courses Content
- All Organizations Content
- Institution Content

Basic Search

Advanced Search

Course Tools

Evaluation

Grade Center


- Needs Grading
- Full Grade Center
- Assignments
- Tests

Users and Groups

Customization

Packages and Utilities

Help



Experiment 2 - Charge to Mass Ratio for Electron by Prabu Karthick Parameshwar and Sriram Sundararaman.pdf

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GRADE 16/20

LAST GRADED ATTEMPT

ATTEMPT 16/20

3/31/15 9:12 PM

GRADE BY RUBRIC

[RUBRIC](#) Used for Grading

FEEDBACK TO LEARNER





File Name

graded Experiment 2 - Charge to Mass Ratio for Electron by Prabu Karthick Parameshwar and Sriram Sundararaman formal commented.pdf [Mark for removal](#)

[Add Notes](#)

[Cancel](#) [Save Draft](#) [Submit](#)

SUBMISSION

 [Experiment 2 - Charge to Mass Ratio for Electron by Prabu Karthick Parameshwar and Sriram Sundararaman.pdf](#) 

COMMENTS

Prabu Parameshwar

3/31/15 9:12 PM

This is the experiment written in the formal lab report style.

APPENDIX. Reports submission and marking.

- ▼ Winter-2015-PHY294H1-S-PRA0101 (QUANTUM AND THERMAL PHYSICS)
 - Home Page
 - Announcements
 - Syllabus
 - Course Materials
 - Discussion Board
 - Tools
 - My Grades
 - Contacts
 - Library Resources
 - About Your Course
- COURSE MANAGEMENT
 - ▼ Control Panel
 - ▶ Content
 - ▶ Course Tools
 - ▶ Evaluation
 - ▼ Grade Center
 - Needs Grading
 - Full Grade Center
 - Assignments
 - Tests

Grade Center : Full Grade Center

When screen reader mode is on, the Grade Center data appears in a simplified grid. You cannot freeze columns or edit inline, making it easier to navigate using the keyboard. To enter a grade, access a cell's contextual menu and click **View Grade Details**. When screen reader mode is off, you can type grade directly in a cell on the Grade Center page. To enter a grade: click the cell, type the grade value, and press the Enter key to submit. Use the arrow keys or the tab key to navigate through the Grade Center. [More Help](#)

Create Column
Create Calculated Column
Manage
Reports
Filter
Discover Content
Work

Move To Top
Email
Sort Columns By: Layout Position
Order: Descend

Grade Information Bar Last Saved: April 17, 2015 1

Last Name	First Name	Student #	Weight 1	Weight 2	Weight 3	Weight 4	Formal report a
	Shervin		17.50	17.50	19.50	--	17.00 (85.00%)
	Aiden		16.50			17.50	16.50 (82.50%)
	Harris		19.00				19.00 (95.00%)
	Leon		18.00				16.50 (82.50%)
	Dami		18.00				16.50 (82.50%)
	Kimberley		18.00			18.50	19.00 (95.00%)
	Balthazar		19.00				19.00 (95.00%)
	Eugene		17.50	17.50	16.50	16.50	17.50 (87.50%)
	Yu		19.50	19.50	17.50	--	17.00 (85.00%)
	Xinyi		18.00	15.00	16.00		15.00 (75.00%)
	Stewart		17.00	--	16.00	16.00	17.00 (85.00%)
	Jenni		19.50	19.50	18.00	18.00	18.00 (90.00%)

Selected Rows: 0
Icon L

- View Grade Details
- Quick Comment
- Exempt Grade
- Attempt 3/5/15 17.50

APPENDIX. Reports submission and marking.

▼ Fall-2014-PHY293H1-F-PRA0101.PRA0103.PRA0102.PRA0101 (WAVES AND MODERN PHYSICS/WAVES AND MODERN PHYSICS)

- Home Page
- Announcements
- Syllabus
- Course Materials
- Discussion Board
- Tools
- My Grades
- Contacts
- Library Resources
- About Your Course

COURSE MANAGEMENT

Control Panel

Content

Fall-2014-PHY293H1-F-PRA0101.PRA0103.PRA0102.PRA0101
Krasnop1 Content
All Courses Content
All Organizations Content
Institution Content

Basic Search
Advanced Search

Course Tools

Evaluation

Grade Center

Course Content: Fall-2014-PHY293H1-F-PRA0101.PRA0103.PRA0102.PRA0101

The Content Collection provides central file storage for all content. When creating content for your course, you can link to items anywhere in the Content Collection. When you change an item in the Content Collection, all links to the item reflect those changes. Using the links in the **Control Panel**, you can access the content in your present course, in all courses you teach, in all of your organizations, or in all of the courses in the institution. [More Help](#)

Upload Create HTML Object Create Folder

<input type="checkbox"/>	File Type	Name	Edited	Size	Permissions
<input type="checkbox"/>	Folder	Lab reports graded by AC	Nov 11, 2014 11:15:43 AM	25.0 MB	
<input type="checkbox"/>	Folder	Lab reports graded by EL	Nov 18, 2014 11:29:59 AM	41.6 MB	
<input type="checkbox"/>	Folder	Lab reports graded by FK	Oct 8, 2014 2:50:38 PM	0	
<input type="checkbox"/>	Folder	Lab reports graded by GM	Oct 8, 2014 2:51:38 PM	0	
<input type="checkbox"/>	Folder	Lab reports graded by JF	Oct 23, 2014 4:32:11 PM	13.1 MB	
<input type="checkbox"/>	Folder	Lab reports graded by JN	Nov 11, 2014 1:01:15 PM	42.7 MB	
<input type="checkbox"/>	Folder	Lab reports graded by SP	Oct 8, 2014 2:51:20 PM	0	
<input type="checkbox"/>	Folder	Lab reports graded by VSV	Nov 13, 2014 9:23:46 PM	23.4 MB	
<input type="checkbox"/>	Doc	Exercise.doc	Sep 8, 2014 1:50:16 AM	103.5 KB	
<input type="checkbox"/>	Doc	Experiment 1.doc	Sep 8, 2014 1:54:19 AM	25.5 KB	
<input type="checkbox"/>	Doc	Experiment 2.doc	Sep 8, 2014 1:56:18 AM	25.5 KB	

APPENDIX. Reports submission and marking.

Fall-2014-PHY293H1-
F-PRA0101.PRA0103.PRA
0102.PRA0 (WAVES AND
MODERN
PHYSICS/WAVES AND
MODERN PHYSICS)

- Home Page
- Announcements
- Syllabus
- Course Materials
- Discussion Board
- Tools
- My Grades
- Contacts
- Library Resources
- About Your Course

COURSE MANAGEMENT

- Control Panel
- Content
- Fall-2014-PHY293H1-
F-PRA0101.PRA0103.PRA010
Krasnop1 Content
- All Courses Content
- All Organizations Content
- Institution Content

Basic Search
Advanced Search

- Course Tools
- Evaluation
- Grade Center

Course Content: Lab reports graded by AC

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- Upload
- Create HTML Object
- Create Folder

<input type="checkbox"/>	File Type	Name	Edited	Size	Permi
<input type="checkbox"/>		Cavendish Rago and Brandimarte.docx	Oct 15, 2014 10:35:27 AM	2.36 MB	
<input type="checkbox"/>		Diffraction and Interference - Wesley Heung and Alyf Janmohamed.docx	Nov 5, 2014 10:11:05 AM	449.3 KB	
<input type="checkbox"/>		Eddie and Rumpfels.docx	Sep 27, 2014 10:28:06 AM	330.9 KB	
<input type="checkbox"/>		Evaporation of a Silver Film - Denise Yap Isaac Chung Baiyu Wang.docx	Nov 11, 2014 7:47:08 AM	4.19 MB	
<input type="checkbox"/>		Evaporation of a Silver Film by Brandon Hadfield and Joshua Calafato.pdf	Oct 15, 2014 1:23:32 PM	225.7 KB	
<input type="checkbox"/>		Exercise by Borren Moe and Alex Lam.docx	Sep 27, 2014 9:35:49 AM	414.7 KB	
<input type="checkbox"/>		Exercise by Josh Calafato and Brandon Hadfield.docx	Sep 30, 2014 12:36:22 PM	1014 KB	
<input type="checkbox"/>		Exercise by Zeev Suprun and Gideon Blinick.docx	Sep 30, 2014 1:15:27 PM	204.9 KB	
<input type="checkbox"/>		Exercise by Zeqi Li and Xiao Pan Yuan.docx	Sep 30, 2014 12:57:35 PM	308.0 KB	
<input type="checkbox"/>		Exercise1PavoneSolomahdoc.docx	Sep 30, 2014 1:39:21 PM	115.0 KB	
<input type="checkbox"/>		Experiment 1 by Balthazar Crane and Mark Grecni.docx	Sep 27, 2014 9:37:51 AM	396.6 KB	
<input type="checkbox"/>		Experiment 1 by Deng Pan and Xiuyan Yu Final.docx	Oct 21, 2014 4:05:34 PM	2.45 MB	
<input type="checkbox"/>		Experiment 1 Interference and Diffraction by Lauren Chee and Alexandra Davidson.pdf	Oct 21, 2014 10:51:19 AM	1.38 MB	

Questions?

Thank you!