L. Paul Rosenberg

Faculty Learning Community
2003-2004

Learning Portfolio

Teaching Philosophy:

My Background

I have been teaching in one form or another for most of my adult life. My first experience in teaching was when I served as a math tutor while attending Old Dominion University. I enjoyed the rewards that working with others offered and from that experience, I have directed my life's goals. I joined the faculty of RIT in 1981 and through my first term here, I thoroughly enjoyed my teaching and felt very confident of my teaching abilities.

When I moved to industry in 1989 my illusions were quickly shattered when I was able to observe students that I had taught having difficulties with concepts that I felt that I had firmly imbedded in their education. I had, at that time, the opportunity to repair these learning deficiencies. Recognizing that I could still contribute to the education of young scientists, I took the opportunity afforded by my industrial employment to foster a co-op program at my company. This allowed me to continue to develop RIT students into competent and productive scientists in an outside the classroom setting.

When my company decided to leave Rochester, I had the fortunate opportunity to return to RIT and make education my primary career once again. I am very grateful for the opportunity to return. Once again, I was faced with the dilemma prerequisite material that I thought was being well taught by my very competent colleagues was not well recalled as soon as the next quarter. I was sure that when the students that I taught in the first year arrived at my advanced courses, they would be well prepared and ready to advance at the upper levels. To my shock, this was clearly not the case. It was time to take stock and find out what the problem was. It wasn't just the others, it was me too.

Philosophy

My teaching philosophy is very simple. It is to prepare our student with sufficient background and sufficient learning skills to allow them to become lifetime learners. This would mean that they have a full command of the basics in chemistry and from these basics be able to construct the knowledge needed for their careers. This would by done by having them master both the knowledge base and the practical skills to work at more advanced intellectual levels. What I have grown to realize is that I need to improve my techniques of teaching and to do timely assessment to make sure that the learning and the 'learning to learn' has happened.

At the start of last year I had a fairly clear metaphor of teaching. After this year in the learning community I see that I have made some incorrect assumptions which, now that I

know, will hopefully allow me to improve my teaching. In spite of this, I still feel that my original metaphor is still appropriate and valid. That metaphor is that of the "Story Teller". Now that am nearing the end of my career I bring stories to the class that tie to the lesson at hand. Sometime the stories are humorous, sometime serious but always with a tie to the importance of the topic at hand to everyday life at some level. Sometimes it is a practical application, a science ethics issue or an amplification of how the topic of study ties to the students expected career choice. Many of the stories tie into learning objectives and can provide a framework for student recall. The stories add an extra dimension of personality that will transfer some my enthusiasm for the subject matter to the students.

In addition, my philosophy calls for me to teach to the mastery of the material. I have seen that most of our students, including students that I have taught, take and attitude of 'learn and discard'. They only hold material until the next exam or perhaps if we are lucky until the end of the quarter. This has always worked for them before and has become their learning paradigm. They have learned to be good students, not good learners. This does not allow them to be properly prepared for graduate school of their first jobs. This is an attitude that most of our students bring to us from their high school careers and one that we must work diligently to overcome.

Syllabus

See First Appendix, Two courses given as examples.

Learning Community Project

Problem Statement

The chemical separations course has an associated laboratory. Since this course requires that students rotate using our limited equipment at hand, many of the students do labs without having covered the background material in lecture yet. We expect in these cases that the students work ahead so they can understand the basics. One-on-one lab instruction is also used to fill the gap in these circumstances. This out of order coverage is forced on us due to the nature of available equipment but it can work to some student's advantage since they are familiar with the hardware when they get to the class material. What the students find most difficult is the manipulation of the data to determine the experimental results. All the students have had exercises in previous courses that make these calculations a reasonable expectation; however, most struggle with the task. What was historically done was to sit with small groups as they needed the refresher on the topic. Since this is a class of about sixty students this could be a really daunting job.

Proposed Solution

Since many students requested help at the level of "just tell me how to do it", it was important to prepare a strategy to include active learning. To this end, a brief learning unit was developed to take advantage of the concept of programmed learning. In programmed learning the student is given instructional material followed by a question with a choice of possible answers. The student makes a selection and is then given immediate feedback on the choice. This feedback is an 'attaboy' for the correct answer or an explanation on why that selection was incorrect. Historically this was originally done by flipping pages in a workbook. This proposal was carried out by setting the project out in web based html format. A copy of the printed exercise is included as Appendix 2 and the html coding is given in Appendix 3. The FLC poster presentation is presented as Appendix 4..

Faculty/Student Partners

This is one aspect of the project that I did not take full advantage of. I did discuss my proposed project with the learning community and did discuss the idea of the project with Laura Tubbs of the Chemistry department. I had two students that were not part of the course go through the exercise and give me feedback. Both seemed to like the project. Their e-mail evaluations are included ad Appendix 7. The original and modified proposals are presented as Appendix 5.

Project Assessment

As the assessment of my project, I gave the students a survey that was given during the final exam period. I also made in informal evaluation of the quality of the work submitted using the exercise. My sense was that the project did provide a meaningful learning experience. Raw data is included as Appendix 8. Charts of the student's impressions are presented as Appendix 6. A summary spreadsheet is presented below.

Summary of Programming Learning Exercise
FLC 2003/4

	What did you think about this exercise		Would you use if available for other labs		Format			
Response	#	%	Would use	Would not use	Useful		Confusing	
Didn't Know About Assignment	15	-	10					
Didn't need to use	3	-	1	1				
Not helpful	5	17%	4	1	0	0%	5	100%
Somewhat	17	59%	15	0	9	53%	8	47%
Very Helpful	7	24%	7	0	7	100%	0	0%

Evaluations Returned	47	
Students that used exercise	29	62%
Percent that would for other labs.		95%
Percent that would not use for other labs.		5%

L. P. Rosenberg

Summary of the Project Results

I consider the project a success. It met my primary criterion of assisting with the laboratory preparation for most of the student participants. Several students did not bother to carry out the assignment. Since the assessment was blinded I do not know if these were good students that did not need the refresher but this could readily explain this factor. Sixty-two percent of the students that answered the survey used the exercise. Of these, 83% found the exercise either 'somewhat' or 'very' helpful. Ninety-five percent of those that answered the survey said that they would use an equivalent tool for other labs. Perhaps the biggest issue that these students faced was the programmed learning format, which they found somewhat confusing. This issue can be addressed with better explanation of the tool.

I did discover that there was a small percentage of students that found the exercise insufficient to allow them to understand the concepts of the lab. This is very distressing and a major concern to me. These students are near the end of their programs! They have succeeded here and yet will leave and go onto the workplace unprepared. How do we address this issue? What can we do to improve what we do to get around this significant problem? Is this a case of 'social promotion' (retention) at the college level? This is a question for another time but it is a real concern.

Timeline

The project was designed and coded during the early weeks of the spring quarter and students used the learning tool as the needed it in the course during the quarter. The learning tool was also used for the summer quarter offering of the course. No formal assessment was given due to the small class size in the summer.

Teaching Goals Inventory

I ran the online version (http://www.uiowa.edu/~centeach/tgi/) of this tool on a couple of my courses during the winter quarter of 2003/2004. It was very informative in building goals in class syllabi. I redid an inventory for the Chemical Separations Course this year. One assessment from each group is attached as Appendix 2. This was an eye opening exercise but, as is, directs attention to the total learning process. I can readily see where I am directing my efforts and it clearly shows where my students must (hopefully) be getting educated elsewhere. It would be a very interesting exercise to run this Inventory on an entire degree program. I would hope that we would see that we are providing a balanced education. This might be a useful exercise for a campus wide investigation.

Reflections

In short, this was a very productive year in terms of my understanding on how to improve the learning experience of my students. This included the FLC itself and two succeeding events that built on the solid foundation built from the FLC. The FLC was made up of the biweekly sessions of the community, attendance of the Lilly Conference on College Teaching and the FLC project. Once I had become involved in the teaching improvement process, I then attended as best as I was able workshops on learning offered during the course of the year. I also attended the Faculty Institute on Teaching and Learning at the end of the spring quarter. The FLC presentation was a logical conclusion to our yearlong journey. Dee Fink's book was also an excellent wrap-up that tied many of the key concepts that we discussed during the course of the year. The final activity of the year was to attend a workshop held at the University of New Hampshire on using POGIL to teach chemistry. Elements taken from each of these aspects will serve to assist me in improving my teaching.

The Sessions

The third FLC was made up of nine faculty from most of RIT's colleges. We were a productive group and one of the real benefits of the program was getting to know several faculty from across campus very well. These interactions will serve to assist us all in the future. The network that we have built has already paid dividends. One member was able to put me in contact with one of my former graduate students that he met at a conference.

The FLC met under the expert direction of Susan Donovan who was able to guide us along in our year of exploration. We met as a group approximately fifteen times. During the first quarter, we went through what might be considered the basic training of quality teaching. The second quarter we started our projects and discussed the Lilly Conference and in the final quarter we wrapped up our projects, made our presentations and met with Lynn Wild and with Dave Neuman to discuss ways to move on from this year's activities.

The Lilly Conference

This was an excellent conference. It allowed our community to gel as a group and made the rest of the program back at RIT much more productive. The presentations ranked from excellent to fair but the keynote lectures and the lectures from some the big names were truly excellent.

I will provide a short synopsis on a few of the key players that made presentations that I learned from. (Once common tread upon reflection is how important the lecturer's enthusiasm was toward effective communication and learning).

Ron Berk: Humor is the Classroom. He gave more that one talk on how to employ humor in the class. He is very purposeful in doing this and does very scripted and sometimes very elaborate humor bits to assist in his teaching of statistics. He attempts to use humor to fortify key class concepts. I have always attempted to enliven my classes with humor and to use the humor at key points to stress concepts. I tend to be much less scripted as this works as well for me.

Regina Barreca: She did an excellent talk also on humor in the classroom. Her major take away message however was to focus on the difference on gender in learning. I was able to read her book "They Used to Call me Snow White, But I Drifted" after returning from the conference. Nan Schaller gave me the book which I then passed onto others.

Tom Angelo: He was an outstanding counter-example from most of the rest of the speakers. His book of "Classroom Assessment Techniques" is an excellent source of ideas on assessment but his talk was rather hostile, arrogant and uninspiring. He did fortify the importance of assessment in our teaching.

Jim Eison: Gave an excellent presentation of how to get us to encourage our student to be more active learners.

Robert Grossman: Gave two very interesting talks. One on hidden transformation and how to use them to teach science. In his case, it was the teaching of psychology. His second talk was a very provocative on identifying hidden prejudices when work with student of other backgrounds.

William Harwood: He gave two presentations and his talks were of interest since he was the only presenting chemist at the conference. His first talk on scientific enquiry was not very informative, especially in light what I learned in my attendance in the summer POGIL workshop.

Barbara Millis and Philip Cottell: Gave an excellent workshop on Cooperative Learning. The course was presented as a pre-conference workshop session and all of the RIT community, except one, attended it. This workshop was very useful and I was

immediately able to put the tools I learned there to use the following quarter. My application of the tools was worthwhile but needs some further development. I felt that my efforts here suffered from not having tight learning objectives and I had issues with uneven participation of the students. This is where POGIL ties in so nicely with our FLC.

The FITL

The FITL allowed us to present our impressions to the campus community. This, along with the presentation late in the spring quarter, allowed us to let the campus know about this wonderful program. I would like to point out however that attendance at both of these events was rather lackluster.

The second benefit of the FITL was this year's gift book. Dee Fink text was outstanding and was a fitting read to tie together the concepts that we have covered during the course of the year.

POGIL

After the FITL I felt that I had gained significantly in my understanding of how to improve my teaching to allow me to provide a more rewarding learning experience. I have started to employ many of these tools. I have enhanced my syllabi; I have added some cooperative learning in one of my classes and have started to think more systematically about my approach to teaching. These are all outcomes based on my FLC year experience. But how was I going to apply this to the teaching of fact based chemistry? I think I see a way. The solution might be with POGIL (Process Oriented Guided Inquiry Learning). This is an NSF funded program that is currently in its dissemination phase. This is a teaching methodology , much like cooperative learning, where student work in groups to construct (process oriented) chemistry knowledge. It is a new way of teaching based on in class exercises tailored to the methodology. The materials are ready for use in general, organic and physical chemistry but not in my area, which is analytical. Information about POGIL included as the final appendix I plan to start using POGIL modules that fit into my curriculum during this current year. I hope to develop modules in analytical so I can expand the use of this tool.

POGIL has a web presence, which can be found at http://www.pogil.org/

Summary

Being a member of the FLC has been a highlight of my teaching career. This FLC year has been the learning that is most often missed on the common path to college teaching. It has allowed me to build a sound pedagogical framework to improve my teaching. I have observed the failings of our graduates from the industrial side and have been working to address these shortfalls. However, up to now I have poorly understood why

the problems were there. We have been failing to have our students learn many of the important factual goals of our programs but instead have taught them to be successful students and in most cases have taught them to be successful chemists. Many times it is the not the 'on syllabus' goals that help them succeed but rather the 'off syllabus' learning that happens in spite of our efforts. These include the work ethic that they pick up on co-op or in research, time management skill they pick up to survive or many of the other things that come along in their four years here.

I will now attack the 'learn and discard' mentality that many students have. Meaningful learning is the answer. This is facilitated by giving the student a framework to retain what is being taught.

I apologize for the lateness of my portfolio. There is no excuse for its tardiness. The process of pulling together the document has been the final learning experience of the FLC and the portfolio has been an integral part of the full FLC process. It might have been very helpful to build this portfolio throughout the process. I would love to read about my thoughts at the start of the FLC year.

Suggestions

This was a very valuable program and should be continued. Even better, it should be expanded. Nine faculty at a time will never build a critical mass on campus.

It might have been helpful to have had some written assignments in the course of the year. Very brief assignments would have been fine and it would have given us something to look at and to see how we had progressed.

We need to find a way keep the momentum going beyond the first year. I really enjoyed visiting the community this year. Perhaps some of us could come back and offer to review projects of the current FLC group or assist in some other way.

Perhaps we need to have our little program inserted into the new long range plan. A goal could be set to have about 15% of the faculty having gone through this program or some similar program by the end of the plan term.

Perhaps the coordination of the campus learning enhancement efforts could become a primary responsibility of a key person in the Provosts office.

Acknowledgements

I am sincerely thankful to the provost and the dean in their generous support to allow me to profit from this program. I am also indebted to my fellow community members for their support and fellowship during the year. We had a great group and everyone made significant contributions. I am most grateful to Susan Donovan for her patience and mentorship during this year. Her efforts, well beyond the expectations of her very

important primary job, have been the true spark and source of success of our entire Faculty Learning Community.

Chemical Separations Syllabus (1008312)

Analytical Chemistry: Separations

SCHA-312-01
Spring 20034
Room 08-2355

Instructor: L. Paul Rosenberg
Office 08-A256
Phone 475-6159 E-mail lprsch@rit.edu

Required Text and Materials:

Text: D. C. Harris, Quantitative Chemical Analysis (New York: W H Freeman, 6 th Ed. 2002.) Older editions will not be suitable for this course!

Class Home Page: http://www.rit.edu/~lprsch/SCHA312Home.htm class news and homework specifics. This page will be updated routinely during the course of the quarter.

On-Line Text: http://bcs.whfreeman.com/qca/ (make sure you enter my e-mail address properly)

COURSE OBJECTIVES:

1) To learn the key concepts of chemical separations. These include:
   a) Solvent extraction, partitioning equilibrium
   b) Plate Theory
   c) Rate Theory
   d) Gas Chromatography
   e) Liquid Chromatography and separations mechanisms
   f) Capillary electrophoresis
2) To understand data treatment / common calculations for separations data.
3) To understand Mass Spectrometry

Syllabus: This syllabus is a general course outline and may be modified.

Topic	Reading Assignment
Introduction	Chapter 0 and Chapter 23
Solvent Extraction	Web Material and Chapter 23
Chromatography, Plate Theory	Chapter 23

Chromatography, Rate Theory	Chapter 23
Gas Chromatography	Chapter 24
Liquid Chromatography	Chapter 25
IEC, SEC, Capillary Electrophoresis	Chapter 26
Mass Spectroscopy	Chapter 22
Other Methods	Web Material

Grading:

Examinations

i Two/three hour exams (about 100 points each) and a cumulative f nal (100 points) will be given during the course of the quarter. Exams will be short answer and problems similar to homework assignments. I reserve the right to give quizzes and adjust the above exam and homework weights. You will also be required to do the assigned On-Line Assignments from the text (10% of your grade). You will need to register at the web site. For the instructor you must use my RIT e-mail address. (lprsch@rit.edu). The first character is an l (ell), not the number one.

Students who do not appear for examinations will receive no credit for the exam. Makeup exams will only be allowed for genuine emergency situations and will be scheduled at the convenience of the instructor.

Homework (30 % of the grade)

1. The total points for each homework assignment are indicated at the top of the homework problem sheet.

2. Homework assignments may be resubmitted with corrections throughout the quarter. However, they must be submitted the first time by the due date assigned.

TO RECEIVE CREDIT FOR EACH HOMEWORK ASSIGNMENT, YOU MUST SUBMIT IT BY THE DEADLINE (NO EXCEPTIONS).

If you did not make an attempt on a problem in your first submission of each homework set (my judgment) you will not be able to receive credit for that problem.

3. You may resubmit your homework with corrections to receive credit as many times as you like. You must attach your previously submitted homework(s) to the end of your resubmitted homework. You only need to resubmit work done in error. Please make your correction clear.

Chemical Separations Syllabus (1008312)

Analytical Chemistry: Separations

SCHA-312-01
Spring 20034
Room 08-2355

Instructor: L. Paul Rosenberg
Office 08-A256
Phone 475-6159 E-mail lprsch@rit.edu

Required Text and Materials:

Text: D. C. Harris, Quantitative Chemical Analysis (New York: W H Freeman, 6 th Ed. 2002.) Older editions will not be suitable for this course!

Class Home Page: http://www.rit.edu/~lprsch/SCHA312Home.htm class news and homework specifics. This page will be updated routinely during the course of the quarter.

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   b) Plate Theory
   c) Rate Theory
   d) Gas Chromatography
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Chromatography, Rate Theory	Chapter 23
Gas Chromatography	Chapter 24
Liquid Chromatography	Chapter 25
IEC, SEC, Capillary Electrophoresis	Chapter 26
Mass Spectroscopy	Chapter 22

Other Methods	Web Material

Grading:

Examinations

Two/three hour exams (about 100 points each) and a cumulative final (100 points) will be given during the course of the quarter. Exams will be short answer and problems similar to homework assignments. I reserve the right to give quizzes and adjust the above exam and homework weights. You will also be required to do the assigned On-Line Assignments from the text (10% of your grade). You will need to register at the web site. For the instructor you must use my RIT e-mail address. (lprsch@rit.edu). The first character is an l (ell), not the number one.

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3. You may resubmit your homework with corrections to receive credit as many times as you like. You must attach your previously submitted homework(s) to the end of your resubmitted homework. You only need to resubmit work done in error. Please make your correction clear.

INTRODUCTION TO CHEMICAL ANALYSIS

Course Number 10-08-261-01
Winter 2004 - 2005

Dr. L Paul Rosenberg
Office: 08-A256
Office Phone 475-6159

E-mail: lprsch@rit.edu (daytime)
Alternate: lpaulr@rochester.rr.com (evening)

Instructors Web Page: http://www.rit.edu/~lprsch

Lectures: M, W and F 11:00-11:50 AM, Room 08-2154
TEXT:

Harris, D. C., "Quantitative Chemical Analysis", 6th Edition W.H. Freeman, 2002 (Required)

Publishers Web Material for this course http://bcs.whfreeman.com/qca

You will need to register the first time you use the site. Use your first and last name as directed, and use lprsch@rit.edu as the instructor's e-mail address.

COURSE OBJECTIVES:

1) To learn the key concepts of quantitative analysis which will serve as a foundation for your chemistry studies.
2) To be able to use spreadsheets to manipulate data and solve problems.
3) To be able to apply concepts to solve new problems.
4) To start the process of learning how to learn on one's own.
5) To work productively with a group to solve problems.

Important note: I can not learn for you. You must take an active roll in this process. If you look at former teaching evaluations you will note that students have commented that they had to teach themselves. See the fourth course objective.

CLASS POLICY:

You must be prepared for class. We will be using active, inquiry and cooperative learning tools. You might feel that you are a Cavia porcellus.
This class will progress at a rapid rate. Therefore it is imperative that you keep up with the homework and reading assignments. The lecture will initially lag behind the laboratory, but they will compliment each other by the end of the quarter. You should be

aware that a minimum of two hours should be spent outside class for each hour of class time.

Tentatively there will be 3 exams and a cumulative final.

HOMEWORK:

You should do all of the assigned problems. The assignments are designed to aid you in your understanding of the concepts presented in the lecture. Some of this homework will be collected and graded.

NOTE: Exam questions are sometimes based on homework problems. Homework assignments will be given in class or be posted on the Web.

ON LINE ASSIGNMENTS:

These are multiple choice exercises at the text book web page to help you review the concepts of the chapters. These assignments are difficult at times and require thought. They are open book and may be taken as many times as you wish. You will be awarded the highest grade you achieve so this is one aspect of your grade under your full control. I have on occasion used these questions on exams. I will assign due dates for when this material will be done. The web site reports your efforts and dates of your attempts.

HELPFUL HINTS:

Read the assignments before the lecture. You may not understand everything, but the preparation will help you to benefit from the lecture and in class discussions..

Study (Read, reflect, reread, ask questions, do assigned work and study for the exams) Like life, Chemistry is not a "spectator sport".

Understand the calculations involved in the homework and lab reports. They will appear on exams.

Use the "Exercises" and "Terms to Understand" at the end of each chapter to aid your study.

TENTATIVE CLASS SCHEDULE:

Week 1	Introduction (Chapter 0), Chapters 1, 2 and 3	
Week 2	Chapter 4	
Week 3	Chapter 5:	Exam #1 Friday, December 17th
Week 4	Chapter 5	
Week 5	Chapter 6	
Week 6	Chapter 7:	Exam #2 Friday, January 14th
Week 7	Chapters 7 and 8	

Week 8	Chapter 8	
Week 9	Chapter 9:	Exam #3 Friday, February 4th
Week 10	Chapters 10 and 11	

Final exams are February 21 to 25, 2005

GRADING:

The final grade for the course will be based on the following:

Class Efforts	10%	
Online Assignments:	10%	(This should be done prior to class coverage of the chapters.)
Submitted Homework	20%	
Exams/Quizzes:	36%	
Final exam:	24%	

You are encouraged to work and study together in this course. Your submissions must be your own work however.

Teaching Goals Inventory Results

Chemical Separations (Lecture and Lab)

This table contains your results. The third column contains the percentage of items within each cluster that you rated "essential." The fourth column contains the average rating you assigned to items within each cluster.

Cluster	Goals Included in Cluster	Percent Rated "Essential"	Mean Rating
I. Higher Order Thinking Skills	1-8	75%	4.63
II. Basic Academic Success Skills	9-17	22%	3.22
III. Discipline-Specific Knowledge and Skills	18-25	75%	4.75
IV. Liberal Arts and Academic Values	26-35	-- none --	2.70
V. Work and Career Preparation	36-43	38%	3.88
VI. Personal Development	44-52	11%	3.11

You identified your primary role as a teacher as "Preparing students for jobs/careers."

It may be useful to compare your results to those of a large sample of teachers. The following table provides mean cluster ratings and the average percentage of items in each cluster rated "essential." The data were collected from over 2,800 faculty members at 15 community colleges and 17 private four year colleges. The sample is clearly biased in the direction of faculty working at institutions with the education of undergraduates as their primary mission, and if your

institution's mission differs, you will want to keep that in mind.

Table 10.3* Mean Cluster Ratings (M) and Percent (%) "Essential" Ratings				
	Four-Year Colleges		*Community Colleges*	
TGI Cluster	*M*	*%*	*M*	*%*
I. Higher order thinking skills	3.05	43	3.09	45
III. Discipline-specific	2.86	37	2.83	36
VI Personal development	2.28	25	2.41	28
V. Work and career	2.27	21	2.50	26
IV. Liberal Arts	2.16	21	2.02	18
II. Basic Skills	2.12	18	2.29	22

*Reproduced with permission.

The table that follows shows the three most-endorsed goals in each of nine disciplines. **If you rated any of these goals "essential" they appear in bold type.**

Table 10.2 Three Top-Priority Teaching Goals, By Discipline									
	Percent Rating Goals "Essential" (click for a key to column headings)								
Teaching goal (TGI #)	*Arts*	*Hum*	*Eng.*	*B. Sk.*	*Soc. Sci.*	*Bus.*	*Med.*	*Sci.*	*Math*
Apply principles (1)				59	57	69	73	61	
Math skills (17)						61		60	84
Terms and facts (18)						61		60	
Wise decisions							70		

(52)									
Analytic Skills (2)			66						73
Self-esteem (45)				63					
Think for self (51)	66	59	75	65	50				
Responsible for self (44)							68		
Value of subject (21)		56			52				
Concepts and theories (19)								71	
Creativity (7)	69								
Writing skills (15)			84						
Aesthetic appreciation (31)	78								
Openness to ideas (27)		56							
Problem solving (3)						57			84

*Reproduced with permission.

The rest of this report lists the goals you rated sorted into groups according to the rating you assigned.

Goals You Rated "Essential"

1. Develop ability to apply principles and generalizations already learned to new problems and situations
2. Develop analytic skills
3. Develop problem-solving skills
4. Develop ability to draw reasonable inferences from observations
5. Develop ability to synthesize and integrate information and ideas
6. Develop ability to think holistically: to see the whole as well as the parts
15. Improve writing skills
16. Develop appropriate study skills, strategies, and habits
18. Learn terms and facts of this subject
19. Learn concepts and theories in this subject
20. Develop skill in using materials, tools, and/or technology central to this subject
21. Learn to understand perspectives and values of this subject
23. Learn techniques and methods used to gain new knowledge in this subject
25. Learn to appreciate important contributions to this subject
39. Develop a commitment to accurate work
40. Improve ability to follow directions, instructions, and plans
41. Improve ability to organize and use time effectively
50. Cultivate an active commitment to honesty

Goals You Rated "Very Important"

7. Develop ability to think creatively
17. Improve mathematical skills
22. Prepare for transfer or graduate study
24. Learn to evaluate methods and materials in this subject
27. Develop an openness to new ideas
30. Develop a lifelong love of learning
36. Develop ability to work productively with others
42. Develop a commitment to personal achievement
43. Develop ability to perform skillfully
44. Cultivate a sense of responsibility for one's own behavior
45. Improve self-esteem/self-confidence
51. Develop capacity to think for oneself
52. Develop capacity to make wise decisions

Goals You Rated "Important"

8. Develop ability to distinguish between fact and opinion
9. Improve skill at paying attention
12. Improve listening skills
14. Improve reading skills
28. Develop an informed concern about contemporary social issues
29. Develop a commitment to exercise the rights and responsibilities of citizenship
32. Develop an informed historical perspective
33. Develop an informed understanding of the role of science and technology
35. Develop capacity to make informed ethical choices

Goals You Rated "Unimportant"

10. Develop ability to concentrate
11. Improve memory skills
13. Improve speaking skills
26. Develop an appreciation of the liberal arts and sciences
37. Develop management skills
38. Develop leadership skills
46. Develop a commitment to one's own values
47. Develop respect for one's own values
48. Cultivate emotional health and well-being

Goals You Rated "Not Applicable"

31. Develop aesthetic appreciation
34. Develop an informed appreciation of other cultures
49. Cultivate physical health and well being

Teaching Goals Inventory... Online!

On this site

TGI Online Home

T.G.I. Background

Take the T.G.I.

Classroom Assessment Techniques- the book

Send comments

Privacy, copyright, disclaimer

Contact us

On this results page

Your results

Comparison table

"Essential" goals by discipline

Goals sorted by **your** rating

- "Essential"
- "Very Important"
- "Important"
- "Unimportant"
- "Not Applicable"

Teaching Goals Inventory Results

Rosenberg Advanced Instrumental
10/13/2003

This table contains your results. The third column contains the percentage of items within each cluster that you rated "essential." The fourth column contains the average rating you assigned to items within each cluster.

Cluster	Goals Included in Cluster	Percent Rated "Essential"	Mean Rating
I. Higher Order Thinking Skills	1-8	38%	4.38
II. Basic Academic Success Skills	9-17	-- none --	3.00
III. Discipline-Specific Knowledge and Skills	18-25	38%	4.13
IV. Liberal Arts and Academic Values	26-35	-- none --	3.00
V. Work and Career Preparation	36-43	25%	3.88
VI. Personal Development	44-52	22%	3.22

You identified your primary role as a teacher as "Preparing students for jobs/careers."

It may be useful to compare your results to those of a large sample of teachers. The following table

provides mean cluster ratings and the average percentage of items in each cluster rated "essential." The data were collected from over 2,800 faculty members at 15 community colleges and 17 private four year colleges. The sample is clearly biased in the direction of faculty working at institutions with the education of undergraduates as their primary mission, and if your institution's mission differs, you will want to keep that in mind.

Table 10.3*
Mean Cluster Ratings (M) and Percent (%) "Essential" Ratings

	Four-Year Colleges		*Community Colleges*	
TGI Cluster	*M*	*%*	*M*	*%*
I. Higher order thinking skills	3.05	43	3.09	45
III. Discipline-specific	2.86	37	2.83	36
VI Personal development	2.28	25	2.41	28
V. Work and career	2.27	21	2.50	26
IV. Liberal Arts	2.16	21	2.02	18
II. Basic Skills	2.12	18	2.29	22

*Reproduced with permission.

The table that follows shows the three most-endorsed goals in each of nine disciplines. **If you rated any of these goals "essential" they appear in bold type.**

Table 10.2 Three Top-Priority Teaching Goals, By Discipline

	Percent Rating Goals "Essential" (click for a key to column headings)								
Teaching goal (TGI #)	*Arts*	*Hum*	*Eng.*	*B. Sk.*	*Soc. Sci.*	*Bus.*	*Med.*	*Sci.*	*Math*
Apply principles (1)				59	57	69	73	61	
Math skills (17)						61		60	84
Terms and						61		60	

facts (18)									
Wise decisions (52)							70		
Analytic Skills (2)			66						73
Self-esteem (45)				63					
Think for self (51)	66	59	75	65	50				
Responsible for self (44)							68		
Value of subject (21)		56			52				
Concepts and theories (19)								71	
Creativity (7)	69								
Writing skills (15)			84						
Aesthetic appreciation (31)	78								
Openness to ideas (27)		56							
Problem solving (3)						57			84

*Reproduced with permission.

The rest of this report lists the goals you rated sorted into groups according to the rating you assigned.

Goals You Rated "Essential"

2. Develop analytic skills
3. Develop problem-solving skills
5. Develop ability to synthesize and integrate information and ideas
18. Learn terms and facts of this subject
19. Learn concepts and theories in this subject
22. Prepare for transfer or graduate study

39. Develop a commitment to accurate work
40. Improve ability to follow directions, instructions, and plans
51. Develop capacity to think for oneself
52. Develop capacity to make wise decisions

Goals You Rated "Very Important"

1. Develop ability to apply principles and generalizations already learned to new problems and situations
4. Develop ability to draw reasonable inferences from observations
6. Develop ability to think holistically: to see the whole as well as the parts
7. Develop ability to think creatively
8. Develop ability to distinguish between fact and opinion
20. Develop skill in using materials, tools, and/or technology central to this subject
21. Learn to understand perspectives and values of this subject
23. Learn techniques and methods used to gain new knowledge in this subject
30. Develop a lifelong love of learning
33. Develop an informed understanding of the role of science and technology
36. Develop ability to work productively with others
38. Develop leadership skills
41. Improve ability to organize and use time effectively
43. Develop ability to perform skillfully
44. Cultivate a sense of responsibility for one's own behavio G NV RO ur
50. Cultivate an active commitment to honesty

Goals You Rated "Important"

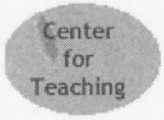
9. Improve skill at paying attention
10. Develop ability to concentrate
11. Improve memory skills
12. Improve listening skills
13. Improve speaking skills
14. Improve reading skills
15. Improve writing skills
16. Develop appropriate study skills, strategies, and habits
17. Improve mathematical skills

24. Learn to evaluate methods and materials in this subject
25. Learn to appreciate important contributions to this subject
26. Develop an appreciation of the liberal arts and sciences
27. Develop an openness to new ideas
28. Develop an informed concern about contemporary social issues
32. Develop an informed historical perspective
34. Develop an informed appreciation of other cultures
35. Develop capacity to make informed ethical choices
42. Develop a commitment to personal achievement
45. Improve self-esteem/self-confidence

Goals You Rated "Unimportant"

29. Develop a commitment to exercise the rights and responsibilities of citizenship
31. Develop aesthetic appreciation
37. Develop management skills
46. Develop a commitment to one's own values
47. Develop respect for one's own values
48. Cultivate emotional health and well-being
49. Cultivate physical health and well being

Goals You Rated "Not Applicable"



Tutorial on Data Preparation on HPLC Laboratory

In this lab we analyzed common over the counter medications for their active ingredients. The products examined were Excedrin, Anacin and one or two generic versions of Excedrin. The experiment carried out is very typical of the kind of analysis one would find in a modern pharmaceutical company for quality assurance on a "finished product". HPLC is used extensively in the pharmaceutical field. Familiarity with the method will be an asset on your resume. More challenging work is in method development, this is when you must devise a method that is specific for the analyte, with suitable sensitivity and robustness for use the quality laboratories. What you have done in lab would be typical daily work. The results of which might be inspected by the FDA on a visit.

HPLC is a form of liquid chromatography. You dissolve your compound in a solvent and then inject this solution into the flowing mobile phase stream that carries the mixture over the column. This analysis is designed with stationary and mobile phase compositions that will cause the active ingredients to separate. Clearly there are more ingredients than just the "actives" but in most cases you do a separate assay should those constituents need to me measured.

Our three compounds of interest are acetaminophen, caffeine and acetylsalicylic acid (aspirin). Since our HPLC separation is based on the partition of the compounds between the polar mobile phase (a mixture of methanol and 1% acetic acid in water) and the non-polar stationary phase (octyl chains attached to the support) then increasing the amount of organic modifier in the mobile phase will push our three active compounds thorough the system more quickly.

In this experiment our goal is to determine how much of the compounds are in our samples. Since the three compound being analyzed in this experiment do not absorb in the visible region we pass the samples through a micro cell illuminated by ultraviolet radiation after the analytes have left the column.

A review question.

What is the law that relates the amount of light absorbed to the concentration of our analyte.

Power Concentration Law

Beers Law

Beer Lambert Law

I don't know.

Yes, great job!! Beer's Law or the Beer-Lambert law are both common names.

If you would like a quick review you may visit this web site from Sheffield Hallam University. (Use you back button to come back to this page)

Our instrument is an Agilent Technologies HP1100 (a common work horse in industry) and our model allows us to work at any single wavelength in the UV-Vis region. As part of the data collection in this lab you have carried out the same separation at several different wavelengths. Wehn you look at those runs you will see the apparent difference between peak sizes. Remember, however. that each wavelength shows the same information. Improper selection of wavelength could lead us to miss a contributing peak. This might be the reason that we do not see the excipients (starch, binding and coating compounds) that are also part of the tablet.

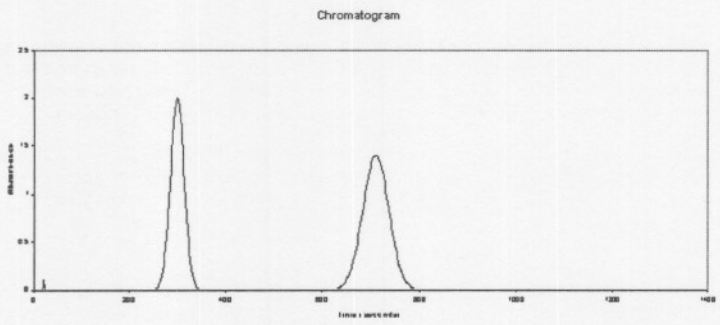
In a simple UV-Vis experiment we have a solution with a fixed concentration so we end up with a single reading for absorbance. In chromatography we was a band of our analyte passing through the detection cell as a function of time. This band is a Gaussian distribution of the analyte that is commonly called a peak. The best way to determine how much is there is to integrate the area under the appropriate peak and use that as a measure of our amount.

This leads us to the following relationship.

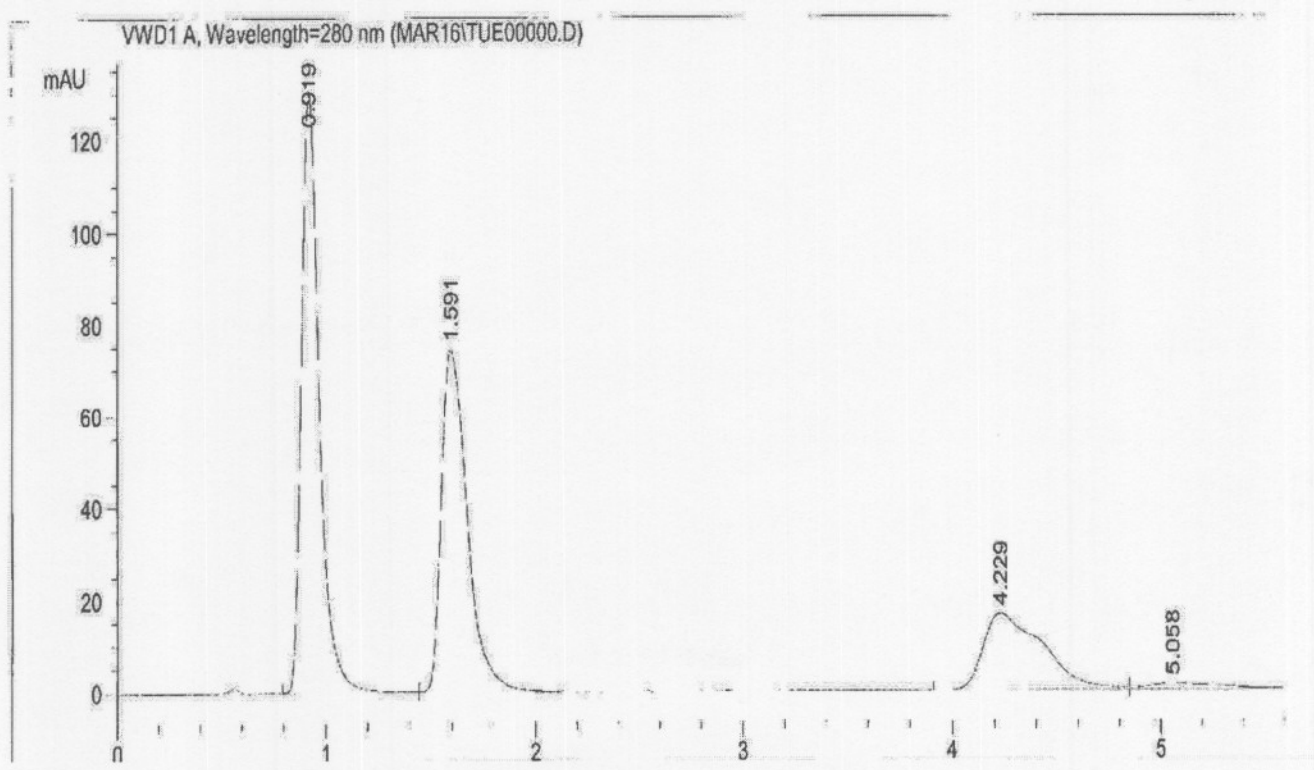
Peak Area = constant * Concentration of analyte

It is directly analogous to Beers law where the eb terms are collected into the constant which we will determine by calibration.

This can lead us to some counterintuitive observation. From the plot below if might appear that there is more of the first peak over the second. Both in fact have the same area.



When one recognizes that one compound can absorb much more at a given wavelength than the another we can readlity see that one must do the the calibrations to do quantitative work. In the chromatogram below the amounts in the formulation for the first three peaks are **1 : 0.26 : 1** (mass ratios) while the peak areas are **1 : 0.82 : 0.42**



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000

Signal 1: VWD1 A, Wavelength=280 nm

Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	0.919	VV	0.0896	775.14294	130.69536	43.7243
2	1.591	VV	0.1355	641.43732	74.44819	36.1822
3	4.229	VV	0.2674	323.13724	16.52611	18.2275
4	5.058	VP	0.3401	33.07874	1.32806	1.8659
Totals :				1772.79623	222.99771	

Do you recall how to do a calibration plot? You have experience with this from your first year's course. You prepare a plot with concentration (in units of your selection) or amount on one axis and instrumental response on the other axis. **Which axis would you place the concentration?**

Either axis would do

Concentration goes on the x axis.

Concentration goes on the y axis.

No, sorry that is not the right answer. By convention we place concentration (our independent variable) on the x axis and our response (dependent variable) on the y axis.

Use your back button and give it another shot.

Great, concentration is the independent variable. You control it! The instrument response is what the result is and goes on the y axis since it is the dependent variable.

Food for thought - can time ever logically go on the y axis?

Below is some example data. How would you prepare your calibration curve?

Dig out a piece of graph paper and draw it with a pencil and straight edge.

Plug it into your graphing calculator and find the line

Prepare a graph using Microsoft Excel

I don't know

Here is the example data

Example Data	
Peak Area	Concentration (mg/mL)
0	0
328	1
658	2
970	3
1314	4
1514	5

This would work but it has several serious drawbacks. It is time consuming, it is susceptible to large errors and can not be readily included in a word processed lab report.

Use your **Back** to return and try another answer..

Great

There are many ways to attack our plots but Excel is the best way to go.

Can you prepare plots using Excel and determine unknown concentrations from them.

Let's give it a try.

Here is the example data

Example Data	
Peak Area	Concentration (mg/mL)
0	0
328	1
658	2
970	3
1314	4
1514	5

Open Excel as a new window and plot the above data and determine the slope, or just load the file from the below link. Loading the below link gives you a spreadsheet with limited functionality. It will be easier to cut and paste into a fresh Excel sheet however.

When you are done come back and answer the following questions.

Excel Example Data

Did you get a plot?

No - give me some help.

What was the slope of the calibration line

a) upward

b) 309.71

c) 0.0032

d) I got a plot, how do I get the slope?

Hit your back button to continue to below the line.

Follow along with the next part of the lesson and see if we can get you started.

Hit Back Button to return.

This would work but you want a plot to include in your **report**. Excel is the way to go.

Back button to return to the main thread..

Well that is the trend we hope to see but since we are going to use our plot to win some information we need a numerical slope and intercept.

Hit you **back** button and try again.

Oops! You did your plot in reverse. I sort of set you up by setting the columns the way I did. Cut and Paste the first column to put it after the second column. Also remember that it is best to show your data as **points** and your fit as a **line**. Also make sure that you do an xy plot..

Hit the **back** button, fix your plot and this question again.

Ok! This is a worthwhile trick to know. It will really come in handy.

Select your plot by left clicking on the plot area.

Right click on any point on the plot. A dialog box will pop up.

Select Add trendline by left clicking on this option. (Make sure the linear box has a black background)

Left click the options tab at the top.

Left click the 'Display equation on chart' and 'Display R-squared value' on chart boxes. Do **not** select 'Set intercept =' option.

Left click OK an the plot will return with the fit equation.

This will be your calibration line to use to determine the concentration from the Area from your chromatogram.

Now you slope should be 309.71.

This slope will have units. These units are Absorbance / mg

Hit **this link** to take you to the next step.

You need to learn this!!. **Drop by** and see me or go to the following typical link for instructions from Illinois State in Normal.. Harris, (your text) Chapter 5, also gives instructions on how to do this.

Return to this exercise when you can do Excel plots.

Great Job

Now let us examine the data in this lab and see how we can determine the amounts of the various active ingredients in Excedrin

---

Let's review.

Got to your lab procedure and review how you prepared your tablets for analysis.

Which procedure below is a serious error (forcing you to restart) in determining the amounts in the tablet.

You grind up a tablet, accurately weigh some of the powder and transfer this powder to a 100.0 mL volumetric.

You weigh the tablet, accurately weigh some of the powder and transfer the powder to a 100.0 mL volumetric.

You weigh the tablet and transfer all of the powder, with rinsing, to a 100.0 mL volumetric flask.

You drop a whole tablet into the volumetric flask, add solvent(s) and wait until it all dissolves.

Remember that you filtered some of this solution, using a syringe filter, taking exactly 2.00 mL of the solution and diluting it up to 25.00 mL in a volumetric.

If you assume the label claim is correct for caffeine (65 mg) then what is the concentration of caffeine in this second solution.

a) 1.00 mg/mL

b) 0.65 mg/mL

c) 0.052 mg/mL

d) I don't know how to do this calculation.

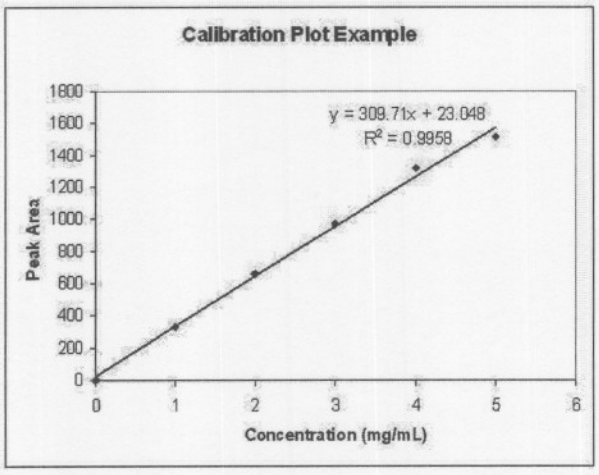
Ok, now lets look at what a proper plot should look like.

Since you are not presenting grey area you should change the plot background to white. This is done by right clicking in the plot area, hitting format plot area and then select the white color. You should also get rid of your horizontal grid lines by right clicking on one of the lines and again select the format grid lines. Again select the white color.

You should also make sure when you were setting up your plot that you label the plot and label both axes with appropriate titles.

A reasonable plot would look like the following example.

Continue to the next page



Oops! Since you do not know the portion that you took then you have made a serious lab error.

You get to start all over again, Lucky You!!!

How could you partially recover some of the work you have done?

Weigh another tablet to get the mass of a tablet and assume that was the mass of your tablet.

Weight several other tablets and determine an average mass with a standard deviation.

Evaporate the solvent from the flask and scrap the recovered solids back into the original powder to get the total for the tablet.

Return to the main tread using this link.

This would work, provided of course you repeat the entire analysis as soon as you can, so long as you let your customer (boss) know what you did. There is a little better option.

Hit your **Back** button for more choices.

This choice is a little better than choice a and a much, much better choice than c. By weighing several tablets you have a measure in the variance in tablet weight so you can report the expected error in your result a little better. Again you should repeat the experiment as soon as you can so you can give a proper answer.

Return to main thread using this link.

Good Luck! If you can pull this one off then your are quite the laboratory magician. Try an different choice.

Use the **Back** button to return and try a different choice.

This is a valid procedure, you must remember to factor the final result by the portion of the tablet that you took.

For example, if the tablet weighed 1.2331 grams and to transfered 0.8977 grams then you must correct the final data by this factor.

Hit the **Back** button to return to return.

This would work just fine. All the sample mass will now be in the flask.

Hit your **Back** button to return.

This would work. It will most likely take a long time for this tablet to completely dissolve. You must like to watch the grass grow and you are also most likely a baseball fan.

Back button to return.

No, that is not correct. Let's think. You first did dissolve the sample in 65 mL but remember that you diluted it up to 100.0 mL. Give the calculation another try.

Back button to return.

No, remember to take into account all your steps. You took an aliquot from your solution and then diluted again. Give it another try.

Back button to return.

Great!!! That is the correct value!.

Continue with exercise.

OK, let's think this over.

You have 65 mg in the entire tablet. This is dissolved into 65 mL of methanol to effect fast dissolution. Then we transfer to this to a 100.0 mL volumetric flask and then fill it to the mark. The concentration now will be the mass over the final volume. The next step is to take 2.00 mL of this solution and dilute to 25.00 mL. This now gives an additional dilution of 2/25.

Hit the **Back** button and give the calculation a try.

OK, Now you know how to calculate the amount of a compound that will be present in your final solutions. Recall however, that you start with different amounts when you make up your standards.

The next step of your lab will have you prepare a standards for Acetaminophen, Aspirin and Caffeine. We first prepare a stock solution of each of these compounds and then we then prepare a series of standards (M0 to M4) to allow us to construct a calibration curve. From each of our stock solutions we take 0.25/0.50/1.0/2.0 and 3 mL and combine all three ingredients to each 10.0 mL standard.

What is the concentration of acetaminophen, caffeine and aspirin in solution M3

a) acetaminophen 0.26 mg/mL, aspirin 1.00 mg/mL and caffeine 0.80 mg/mL

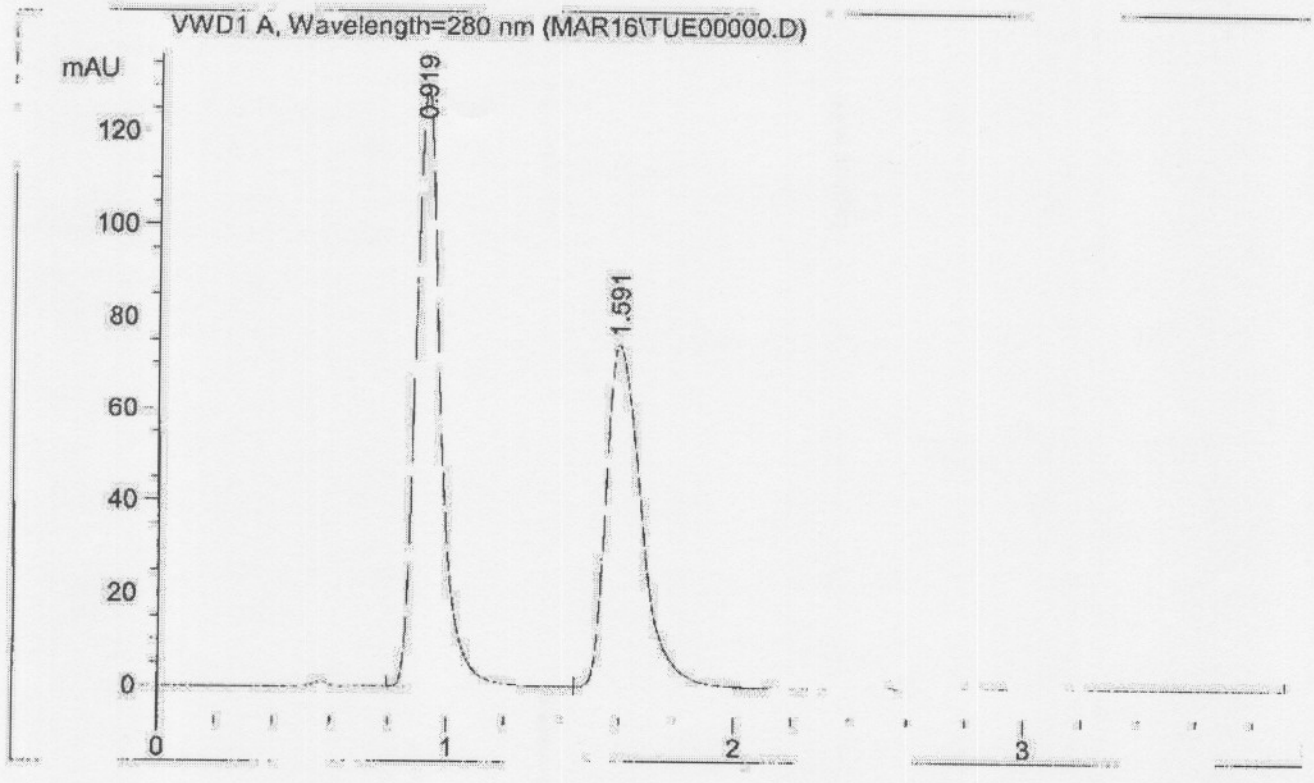
b) acetaminophen 0.052 mg/mL, aspirin 0.200 mg/mL and caffeine 0.160 mg/mL

c) acetaminophen 0.20 mg/mL, aspirin 0.20 mg/mL and caffeine 0.052 mg/mL

d) acetaminophen 2.50 mg/mL, aspirin 2.50 mg/mL and caffeine 0.65 mg/mL

Now we have the concentrations of all the standard solutions (the M series) now all we need is the response for each of the compounds. Recall that you are building a standard curve for each ingredient. You can combine onto one plot or you prepare three different curves. It is up to you. You want to plot the **area** for each.

Lets look at our instrument output.



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000

Signal 1: VWD1 A, Wavelength=280 nm

Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	0.919	VV	0.0896	775.14294	130.69536	43.7243
2	1.591	VV	0.1355	641.43732	74.44819	36.1822

3	4.229	VV	0.2674	323.13724	16.52611	18.2275
4	5.058	VP	0.3401	33.07874	1.32806	1.8659
Totals :				1772.79623	222.99771	

The value that we want to use is in the Area column (fifth from the left). The units are in mAU*sec. This is milli-absorbance units and the seconds allows up to compensate for the fact that the chromatogram is a signal per unit time.

When we have constructed our plot our calibration line for caffeine will be Area = Conc + Intercept

The intercept should pass very close to zero and if it does then you can most likely ignore it. If it is not close to zero see me or your lab instructor. Bring along your plot so we can give you advice. For caffeine this data set we probably had something close to:

Area = 3200*Conc.

If we ran a generic sample of Excedrin, prepared as the other samples, and got a caffeine peak that was 605.23 then how many milligrams of caffeine would be in the generic tablet??

a 605.23 mg

b 236.4 mg

c 18.9 mg

d 2.36 mg

Ok you now should be able to determine the amounts of the three ingredients in all the types of tablets.

Go to the next link to get a review on the other calculations that are called for in this lab.

Go

No, This is the concentration of each of the stock solutions. Remember that each will be diluted in the preparation of M0 to M4.

Back button to try again.

That's correct!

That will be the concentrations of the the three compounds in this standard solution.

Back to continue onto the next topic.

This would be the concentration if you use the amounts in an Excedrin tablet.

Remember you prepared a standard for each compound from pure acetaminophen, caffeine and aspirin.

Give it another try.

Back button to return.

No this is not correct. This would be the concentrations we would have by just dissolving one tablet into 100 mL of solvent.

Although we prepared this solution we never inject it.

Back button and give it another try.

This is not correct. 605.23 is just the area. You need to plug it into your calibration equation to get the concentration of your injected sample.

Back to try another.

Yes this is correct. Great job. You took your solution concentration, factored back for the 2/25 dilution and then mulitplied by 100 mL to get the total milligrams in one tablet.

Back and onto the next section

No, you forgot one important operation. Remember that you took a filtered 2.00 ml of the first solution and diluted it to 25.0 mL. You will need to correct you calculation for this dilution. This is done by multiplying by the reciprocal of the dilution factor.

Back to try again.

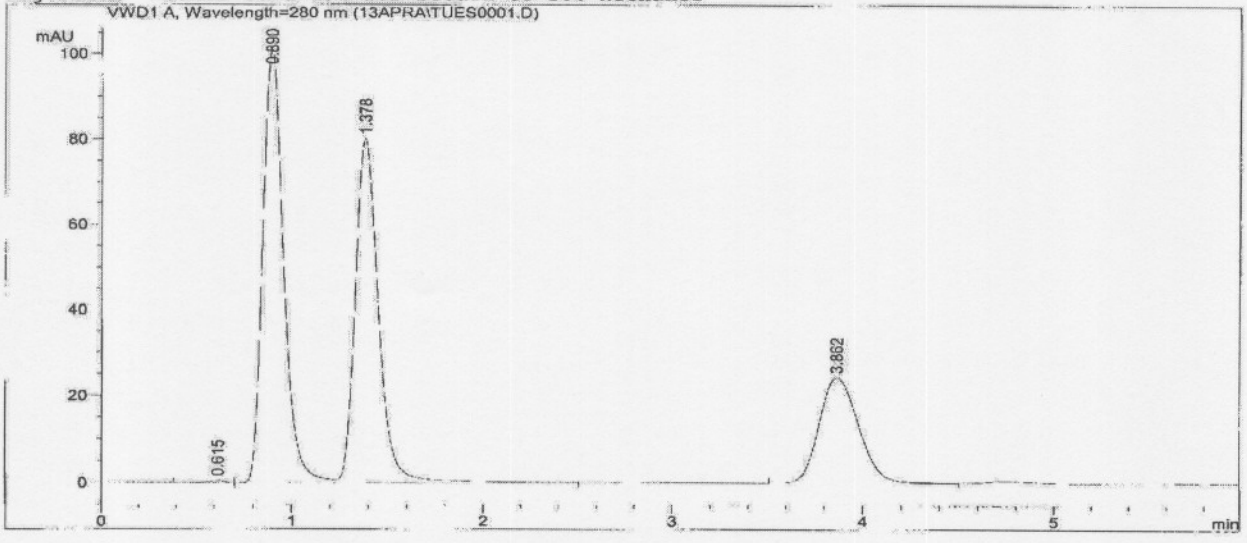
Almost,

This is the answer for the concentration of the sample you analyzed. It will be in mg/mL. You need to find the total mg in a tablet. Since the entire tablet is dissolved in 100 mL of solution the you need to multiply by the 100 mL to factor away this volume.

Back and try again.

Data File C:\HPCHEM\1\DATA\13APRA\TUES0001.D Sample Name: Excedrin

```
Injection Date   : 4/13/2004 11:12:55 AM          Seq. Line :   1
Sample Name      : Excedrin                       Location : Vial 31
Acq. Operator    : 319 Tuaesday Class                 Inj :   1
                                                Inj Volume : 2 µl
Acq. Method      : C:\HPCHEM\1\METHODS\ACEMET1.M
Last changed     : 4/13/2004 8:31:19 AM by 319 Monday Class
Analysis Method  : C:\HPCHEM\1\METHODS\REEQ10.M
Last changed     : 4/15/2004 8:23:46 AM by 319 Thursday Class
SCHA 319 Method 20% Methanol with 80% HOAc(1%) in Water.  Flow Rate of 0.45 ml/min.  ACE C8
column 5 cm Method Run LPR
Samples prepared by class  Run time 6 min 155 bar running pressure  280 nm   10 micro
injection  Method to allow for return to 20% Methanol
```




```
                          Area Percent Report

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000

Signal 1: VWD1 A, Wavelength=280 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]      [min]   mAU   *s    [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   0.615 BP    0.0869    3.12092 5.35482e-1   0.1753
   2   0.890 VV    0.1171  761.68152  101.02673  42.7862
   3   1.378 VB    0.1279  668.53540   80.12670  37.5539
   4   3.862 BV    0.2259  346.86508   24.34367  19.4846

Totals :                  1780.20292  206.03258

 Results obtained with enhanced integrator:

                          *** End of Report ***
```

Instrument 1 4/15/2004 11:21:02 AM 319 Thursday Class Page 1 of 1

From a typical chromatogram let's calculate some of our fundamental chromatographic values.

There is one big caution here - that is that the **width** on the output is the **width at half height**.

You can also assume that t_m is 0.615 minutes and the flow rate is 0.45 mL/min.

The column is 50 mm long and 2.1 mm in diameter.

What is the plate count for the tallest peak (0.890 minutes)

5129	121	57.8
321	42	I don't know

What is the resolution between the first two major peaks.

3.98	2.34
Good	Bad

What is the relative retention between the first two major peaks.

1.55	2.77
0.360	1.09

What is the capacity factor for the first major peak

1.45	0.45
1	I don't know

How short could this column be and still have a resolution of 1.0 between the first two peaks

4.6	2.14
0.91	I don't know

You are close.

You are missing a minor point, the width can be measured at two different places. Did you use the correct formula for the width you have.

Back to return.

You are close.

Recheck the formula and make sure you plugged in correctly.

Back to return.

OK, Great job!

Use the **Back** button to return and try the next question.

This is not that bad.

Recall that the number of plates is a measure of how well a column is able to resolve peaks. This a function of the time in the column and how narrow the peaks are. Check Chapter 23 in Harrris and find the formula that you need to use.

Back button to return and give it a shot.

Not quite.

Recall that you are given the width at half height.

You must adjust for this. You have an equation.

Back Button for another try.

Nice try.

We want to calculate a value so that we can quantify how good or bad a separation is.

Back Button and give it another try.

This is one case where we use our adjusted retention time. Did you you that?

Back to try again

Yes.

You remembered to adjust for the the dead time.

Back to continue to the next question

Almost, remember that this is always expressed as a number greater than 1. .

Go Back to try again.

No, this is not right.

Be careful - make sure you pick up the correct values.

You have used width not retention time here.

Go **Back** to try again.

Don't forget that you need to subtract the time in the mobile phase.

Patch this up and give it another try.

Back to question.

Great, that is exactly correct.

Use the **Back** button and proceed to the next question.

That was just a guess wasn't it.

The capacity factor is an important parameter in chromatography. See Table 23-2 and/or Equation 23-19 in Harris for some help.

Back button and give it another shot.

Capacity factor is nothing more than the ratio of the extra time a compound spends on the column over the time dead or void time.

The capacity factor is an important parameter in chromatography. See Table 23-2 and/or Equation 23-19 in Harris for some help.

Back button and give it another shot.

You are very close.

You just dropped one little math operation. Look ver your work and give it another shot.

Back button to return.

You are very close.

Don't forget you have a square root function and you must account for that. Review how you would do this and give it another shot..

Back button to return.

Great Job!

You are now done.

Back to my home page.

There is a hard way and an easy way to do this problem.

You have an equation for R (Resolution) that involves the Number of Plates, the capacity factors and the separations factor.

You could calculate all of these and plug in and get the required number of plates (which is directly related to Length). But you should realize that the capacity factors and separations factor should be invariant on length.

This allows you to set up a ratio where the ratio of the resolutions equals the square root of the ratio of the Lengths, Give it a try.

Back button to return.

```
<html>
<head>
<title>HPLC1</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p align="center"><font size="+1">Tutorial on Data Preparation on HPLC
Laboratory</font></p>
<p> In this lab we analyzed common over the counter medications for their active
  ingredients. The products examined were Excedrin, Anacin and one or two generic
  versions of Excedrin. The experiment carried out is very typical of the kind
  of analysis one would find in a modern pharmaceutical company for quality assurance
  on a "finished product". HPLC is used extensively in the pharmaceutical field.
  Familiarity with the method will be an asset on your resume. More challenging
  work is in method development, this is when you must devise a method that is
  specific for the analyte, with suitable sensitivity and robustness for use the
  quality laboratories. What you have done in lab would be typical daily work.
  The results of which might be inspected by the FDA on a visit. </p>
<p>HPLC is a form of liquid chromatography. You dissolve your compound in a solvent
  and then inject this solution into the flowing mobile phase stream that carries
  the mixture over the column. This analysis is designed with stationary and mobile
  phase compositions that will cause the active ingredients to separate. Clearly
  there are more ingredients than just the &amp;quot;actives&amp;quot; but in most cases
  you do a separate assay should those constituents need to me measured.</p>
<p>Our three compounds of interest are acetaminophen, caffeine and acetylsalicylic
  acid (aspirin). Since our HPLC separation is based on the partition of the compounds
  between the polar mobile phase (a mixture of methanol and 1% acetic acid in
  water) and the non-polar stationary phase (octyl chains attached to the support)
  then increasing the amount of organic modifier in the mobile phase will push
  our three active compounds thorough the system more quickly.</p>
<p>In this experiment our goal is to determine how much of the compounds are in
  our samples. Since the three compound being analyzed in this experiment do not
  absorb in the visible region we pass the samples through a micro cell illuminated
  by ultraviolet radiation after the analytes have left the column. </p>
<p>A review question. </p>
<p>What is the law that relates the amount of light absorbed to the concentration
  of our analyte.</p>
<p><a href="FLC_HPLC1a.htn">Power Concentration Law</a></p>
<p><a href="flc_hplc2.htm">Beers Law</a></p>
<p><a href="flc_hplc2.htm">Beer Lambert Law</a></p>
<p><a href="flc_hplc1a.htm">I don't know.</a></p>
</body>
</html>
```

```
<html>
<head>
<title>HPLC1a</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p> It has been awhile since you had that in SCHA 262 or SCHA 206 so if you did
  not remember the name that is fine. The name of the law is the Beer Lambert
  Law.</p>
<p>Visit <a
href="http://www.shu.ac.uk/schools/sci/chem/tutorials/molspec/beers1.htm">this
  web site</a> from Sheffield Hallam University if you would like to review the
  concept. (Use you back button to come back to this page)</p>
<p>Now let's rejoin our main thread.</p>
<p><a href="FLC_HPLC2,htm">Next Page</a></p>
</body>
</html>
```

```
<html>
<head>
<title>HPLC2</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>Yes, great job!! Beer's Law or the Beer-Lambert law are both common names.</p>
<p>If you would like a quick review you may visit <a
href="http://www.shu.ac.uk/schools/sci/chem/tutorials/molspec/beers1.htm">this
  web site</a> from Sheffield Hallam University. (Use you back button to come
  back to this page)</p>
<p> </p>
<p>Our instrument is an Agilent Technologies HP1100 (a common work horse in
industry)
  and our model allows us to work at any single wavelength in the UV-Vis region.
  As part of the data collection in this lab you have carried out the same separation
  at several different wavelengths. Wehn you look at those runs you will see the
  apparent difference between peak sizes. Remember, however. that each wavelength
  shows the same information. Improper selection of wavelength could lead us to
  miss a contributing peak. This might be the reason that we do not see the excipients
  (starch, binding and coating compounds) that are also part of the tablet.</p>
<p>In a simple UV-Vis experiment we have a solution with a fixed concentration
  so we end up with a single reading for absorbance. In chromatography we was
  a band of our analyte passing through the detection cell as a function of time.
  This band is a Gaussian distribution of the analyte that is commonly called
  a peak. The best way to determine how much is there is to integrate the area
  under the appropriate peak and use that as a measure of our amount.</p>
<p>This leads us to the following relationship.</p>
<p><font size="+1">Peak Area = constant * Concentration of analyte</font></p>
<p>It is directly analogous to Beers law where the eb terms are collected into
  the constant which we will determine by calibration.</p>
<p>This can lead us to some counterintuitive observation. From the plot below
  if might appear that there is more of the first peak over the second. Both in
  fact have the same area.</p>
<p><img src="twoEqualPeaks.bmp"></p>
<p>When one recognizes that one compound can absorb much more at a given
wavelength
  than the another we can readlity see that one must do the the calibrations to
  do quantitative work. In the chromatogram below the amounts in the formulation
  for the first three peaks are <font color="#008080"><b><font color="#008000">1
  : 0.26 : 1</font> </b></font>(mass ratios) while the peak areas are <font
color="#008000"><b>1
  : 0.82 : 0.42</b></font></p>
<p> </p>
<p><img src="ChromExample.jpg" width="1180" height="1290"></p>
```

```
<p><br>
</p>
<p> </p>
<p> </p>
<p> </p>
<p> </p>
<p> </p>
<p>Do you recall how to do a calibration plot? You have experience with this from
  your first year's course. You prepare a plot with concentration (in units of
  your selection) or amount on one axis and instrumental response on the other
  axis. <b>Which axis would you place the concentration?</b></p>
<p><a href="flc_hplc2a.htm">Either axis would do</a></p>
<p><a href="flc_hplc3.htm">Concentration goes on the x axis.</a></p>
<p><a href="flc_hplc2a.htm">Concentration goes on the y axis.</a></p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF6699" text="#000000">
<p>No, sorry that is not the right answer. By convention we place concentration
 ( our independent variable) on the x axis and our response (dependent variable)
 on the y axis. </p>
<p>Use your back button and give it another shot.</p>
</body>
</html>
```

FLC_HPLC2a.htm

```
<html>
<head>
<title>FPL_HPLC3</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p><font color="#00FF00" size="+1">Great</font>, concentration is the independent
  variable. You control it! The instrument response is what the result is and
  goes on the y axis since it is the dependent variable.</p>
<p>Food for thought - can time ever logically go on the y axis?</p>
<p>Below is some example data. How would you prepare your calibration curve?</p>
<p><a href="flc_hplc3a.htm">Dig out a piece of graph paper and draw it with a
  pencil and straight edge.</a></p>
<p><a href="flc_hplc3d.htm">Plug it into your graphing calculator and find the
  line</a></p>
<p><a href="flc_hplc3b.htm">Prepare a graph using Microsoft Excel</a></p>
<p><a href="flc_hplc3w.htm">I don't know</a></p>
<p>Here is the example data</p>
<table width="34%" border="1" cellpadding="1">
  <tr>
    <td colspan="2">
      <div align="center">Example Data</div>
    </td>
  </tr>
  <tr>
    <td>
      <div align="center">Peak Area</div>
    </td>
    <td>
      <div align="center">Concentration (mg/mL)</div>
    </td>
  </tr>
  <tr>
    <td>
      <div align="center">0</div>
    </td>
    <td>
      <div align="center">0</div>
    </td>
  </tr>
  <tr>
    <td>
      <div align="center">328</div>
    </td>
    <td>
```

```
    <div align="center">1</div>
   </td>
  </tr>
  <tr>
   <td>
    <div align="center">658</div>
   </td>
   <td>
    <div align="center">2</div>
   </td>
  </tr>
  <tr>
   <td>
    <div align="center">970</div>
   </td>
   <td>
    <div align="center">3</div>
   </td>
  </tr>
  <tr>
   <td>
    <div align="center">1314</div>
   </td>
   <td>
    <div align="center">4</div>
   </td>
  </tr>
  <tr>
   <td>
    <div align="center">1514</div>
   </td>
   <td>
    <div align="center">5</div>
   </td>
  </tr>
</table>
<p> </p>
<p> </p>
<p> </p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF6666" text="#000000">
<p>This would work but it has several serious drawbacks. It is time consuming,
  it is susceptible to large errors and can not be readily included in a word
  processed lab report.</p>
<p>Use your <b>Back</b> to return and try another answer..</p>
</body>
</html>
```

FLC_HPLC3a.htm

```
<html>
<head>
<title>FLC_HPLC3b</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>
<body bgcolor="#FFFFFF" text="#000000">
<p><font color="#00FF00" size="+1">Great </font></p>
<p> </p>
<p>There are many ways to attack our plots but Excel is the best way to go.</p>
<p>Can you prepare plots using Excel and determine unknown concentrations from
 them. </p>
<p>Let's give it a try.</p>
<p>Here is the example data</p>
<table width="34%" border="1" cellpadding="1">
 <tr>
  <td colspan="2">
   <div align="center">Example Data</div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center">Peak Area</div>
  </td>
  <td>
   <div align="center">Concentration (mg/mL)</div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center">0</div>
  </td>
  <td>
   <div align="center">0</div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center">328</div>
  </td>
  <td>
   <div align="center">1</div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center">658</div>
```

```
    </td>
    <td>
     <div align="center">2</div>
    </td>
   </tr>
   <tr>
    <td>
     <div align="center">970</div>
    </td>
    <td>
     <div align="center">3</div>
    </td>
   </tr>
   <tr>
    <td>
     <div align="center">1314</div>
    </td>
    <td>
     <div align="center">4</div>
    </td>
   </tr>
   <tr>
    <td>
     <div align="center">1514</div>
    </td>
    <td>
     <div align="center">5</div>
    </td>
   </tr>
</table>
<p> </p>
<p>Open Excel as a new window and plot the above data and determine the slope,
 or just load the file from the below link. Loading the below link gives you
 a spreadsheet with limited functionality. It will be easier to cut and paste
 into a fresh Excel sheet however.</p>
<p>When you are done come back and answer the following questions.</p>
<p><a href="FLCExceldata.xls">Excel Example Data</a></p>
<p>Did you get a plot?</p>
<p>No - <a href="FLC_HPLC3w.htm">give me some help</a>. </p>
<p>What was the slope of the calibration line</p>
<p>a) <a href="flc_hplc3m.htm">upward</a></p>
<p>b) <a href="FLC_HPLC4s.htm">309.71</a> </p>
<p>c) <a href="flc_hplc3o.htm">0.0032</a> </p>
<p>d) <a href="flc_hplc3p.htm">I got a plot, how do I get the slope?</a></p>
<p>Hit your back button to continue to below the line.</p>
</body></html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>Follow along with the next part of the lesson and see if we can get you started.</p>
<p> </p>
<p>Hit Back Button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC3d</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF99CC" text="#000000">
<p>This would work but you want a plot to include in your <b>report</b>. Excel
  is the way to go.</p>
<p><b>Back</b> button to return to the main thread..</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF6699" text="#000000">
<p>Well that is the trend we hope to see but since we are going to use our plot
  to win some information we need a numerical slope and intercept.</p>
<p>Hit you <b>back</b> button and try again.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF6633" text="#000000">
<p>Oops! You did your plot in reverse. I sort of set you up by setting the columns
  the way I did. Cut and Paste the first column to put it after the second column.
  Also remember that it is best to show your data as <b><font
color="#0000A0">points</font></b>
  and your fit as a <b><font color="#0000A0">line</font></b>. Also make sure that
  you do an xy plot..</p>
<p>Hit the <b>back</b> button, fix your plot and this question again.</p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC3p</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>Ok! This is a worthwhile trick to know. It will really come in handy. </p>
<p>Select your plot by left clicking on the plot area.</p>
<p>Right click on any point on the plot. A dialog box will pop up.</p>
<p>Select Add trendline by left clicking on this option. (Make sure the linear
  box has a black background)</p>
<p>Left click the options tab at the top.</p>
<p>Left click the <font color="#0080C0">'Display equation on chart'</font> and
  <font color="#0080C0">'Display R-squared value' </font>on chart boxes. Do <b><font
color="#FF0000">not
  </font></b>select<font color="#0080C0"> 'Set intercept ='</font> option.</p>
<p>Left click OK an the plot will return with the fit equation.</p>
<p>This will be your calibration line to use to determine the concentration from
  the Area from your chromatogram.</p>
<p>Now you slope should be 309.71. </p>
<p>This slope will have units. These units are Absorbance / mg</p>
<p>Hit <a href="FLC_HPLC4s.htm"><b>this link</b></a> to take you to the next
step.</p>

</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC3w</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFF00" text="#000000">
<p>You need to learn this!!. <b>Drop by </b>and see me or go to the following
  <a href="http://www.che.ilstu.edu/baur/215/handouts/Excel_tutorial.pdf">typical
  link</a> for instructions from Illinois State in Normal.. Harris, (your text)
  Chapter 5, also gives instructions on how to do this. </p>
<p>Return to this exercise when you can do Excel plots.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC4</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p><b><font color="#008000">Great Job</font></b></p>
<p>Now let us examine the data in this lab and see how we can determine the amounts
  of the various active ingredients in Excedrin</p>
<hr>
<p>Let's review. </p>
<p>Got to your lab procedure and review how you prepared your tablets for
analysis.</p>
<p>Which procedure below is a <font color="#FF0000">serious error (forcing you
  to restart)</font> in determining the amounts in the tablet.</p>
<p><a href="FLC_HPLC5a.htm">You grind up a tablet, accurately weigh some of the
powder
  and transfer this powder to a 100.0 mL volumetric.</a></p>
<p><a href="FLC_HPLC5B.htm">You weigh the tablet, accurately weigh some of the
  powder and transfer the powder to a 100.0 mL volumetric.</a></p>
<p><a href="flc_hplc5c.htm">You weigh the tablet and transfer all of the powder, with
  rinsing, to a 100.0 mL volumetric flask.</a></p>
<p><a href="FLC_HPLC5d.htm">You drop a whole tablet into the volumetric flask, add
  solvent(s) and wait until it all dissolves.</a></p>
<p>Remember that you filtered some of this solution, using a syringe filter, taking
  exactly 2.00 mL of the solution and diluting it up to 25.00 mL in a volumetric.</p>
<p>If you assume the label claim is correct for caffeine (65 mg) then what is
  the concentration of caffeine in this second solution.</p>
<p>a) <a href="FLC_HPLC5m.htm">1.00 mg/mL</a></p>
<p>b) <a href="FLC_HPLC5n.htm">0.65 mg/mL</a></p>
<p>c) <a href="FLC_HPLC5o.htm">0.052 mg/mL</a></p>
<p>d) <a href="FLC_HPLC5p.htm">I don't know how to do this calculation.</a></p>
<p> </p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC4s</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>Ok, now lets look at what a proper plot should look like.</p>
<p>Since you are not presenting grey area you should change the plot background
  to white. This is done by right clicking in the plot area, hitting <font
color="#0080C0">format
  plot area </font>and then select the white color. You should also get rid of
  your horizontal grid lines by right clicking on one of the lines and again select
  the <font color="#0080C0">format grid lines</font>. Again select the white color.
</p>
<p>You should also make sure when you were setting up your plot that you label
  the plot and label both axes with appropriate titles.</p>
<p>A reasonable plot would look like the following example.</p>
<p><a href="FLC_HPLC4.htm">Continue</a> to the next page</p>
<p><img src="calib_plot.jpg"></p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5a</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>Oops! Since you do not know the portion that you took then you have made a
  <font color="#FF0000">serious</font> lab error. </p>
<p>You get to start all over again, Lucky You!!!</p>
<p> </p>
<p>How could you partially recover some of the work you have done?</p>
<p><a href="FLc_hplcaa.htm">Weigh another tablet to get the mass of a tablet and
assume that
  was the mass of your tablet</a>.</p>
<p><a href="flc_hplc5ab.htm">Weight several other tablets and determine an average
mass
  with a standard deviation. </a></p>
<p><a href="flc_HPLC5AC.htm">Evaporate the solvent from the flask and scrap the
  recovered solids back into the original powder to get the total for the tablet.</a></p>
<p>Return to the main tread using this <a href="FLC_HPLC4.htm">link</a>.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5aa</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFF99" text="#000000">
<p>This would work, provided of course you repeat the entire analysis as soon
  as you can, so long as you let your customer (boss) know what you did. There
  is a little better option.</p>
<p> </p>
<p>Hit your <b>Back</b> button for more choices.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5ab</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFCC" text="#000000">
<p>This choice is a little better than choice a and a much, much better choice
  than c. By weighing several tablets you have a measure in the variance in tablet
  weight so you can report the expected error in your result a little better.
  Again you should repeat the experiment as soon as you can so you can give a
  proper answer.</p>
<p>Return to main thread using this <a href="FLC_HPLC4.htm">link</a>.</p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5ac</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>Good Luck! If you can pull this one off then your are quite the laboratory
  magician. Try an different choice.</p>
<p> </p>
<p>Use the<b> Back</b> button to return and try a different choice.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5b</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#00FF99" text="#000000">
<p>This is a valid procedure, you must remember to factor the final result by
  the portion of the tablet that you took.</p>
<p>For example, if the tablet weighed 1.2331 grams and to transfered 0.8977 grams
  then you must correct the final data by this factor.</p>
<p>Hit the <b>Back</b> button to return to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>flc_hplc5C</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#33FF66" text="#000000">
<p>This would work just fine. All the sample mass will now be in the flask.</p>
<p>Hit your <b>Back</b> button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>flc_hplc5d</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#33FF66" text="#000000">
<p>This would work. It will most likely take a long time for this tablet to completely
  dissolve. You must like to watch the grass grow and you are also most likely
  a baseball fan.</p>
<b>Back</b> button to return.
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5m</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>No, that is not correct. Let's think. You first did dissolve the sample in
 65 mL but remember that you diluted it up to 100.0 mL. Give the calculation
 another try.</p>
<p><b>Back</b> button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5n</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>No, remember to take into account all your steps. You took an aliquot from
  your solution and then diluted again. Give it another try.</p>
<p><b>Back</b> button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5o</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#33FF66" text="#000000">
<p>Great!!! That is the correct value!.</p>
<p><a href="flc_hplc6.htm">Continue with exercise.</a></p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC5p</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFF99" text="#000000">
<p>OK, let's think this over. </p>
<p>You have 65 mg in the entire tablet. This is dissolved into 65 mL of methanol
  to effect fast dissolution. Then we transfer to this to a 100.0 mL volumetric
  flask and then fill it to the mark. The concentration now will be the mass over
  the final volume. The next step is to take 2.00 mL of this solution and dilute
  to 25.00 mL. This now gives an additional dilution of 2/25. </p>
<p>Hit the <b>Back</b> button and give the calculation a try.</p>
<p>  </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>OK, Now you know how to calculate the amount of a compound that will be present
 in your final solutions. Recall however, that you start with different amounts
 when you make up your standards.</p>
<p>The next step of your lab will have you prepare a standards for Acetaminophen,
 Aspirin and Caffeine. We first prepare a stock solution of each of these compounds
 and then we then prepare a series of standards (M0 to M4) to allow us to construct
 a calibration curve. From each of our stock solutions we take 0.25/0.50/1.0/2.0
 and 3 mL and combine all three ingredients to each 10.0 mL standard.</p>
<p>What is the concentration of acetaminophen, caffeine and aspirin in solution
 M3</p>
<p>a) <a href="flc_hplc6a.htm">acetaminophen 0.26 mg/mL, aspirin 1.00 mg/mL and
 caffeine 0.80 mg/mL</a></p>
<p>b) <a href="FLC_HPLC6b.htm">acetaminophen 0.052 mg/mL, aspirin 0.200 mg/mL
 and caffeine 0.160 mg/mL</a></p>
<p>c) <a href="FLC_HPLC6c.htm">acetaminophen 0.20 mg/mL, aspirin 0.20 mg/mL
and
 caffeine 0.052 mg/mL</a></p>
<p>d) <a href="FLC_HPLC6d.htm">acetaminophen 2.50 mg/mL, aspirin 2.50 mg/mL
and
 caffeine 0.65 mg/mL</a></p>
<p>Now we have the concentrations of all the standard solutions (the M series)
 now all we need is the response for each of the compounds. Recall that you are
 building a standard curve for each ingredient. You can combine onto one plot
 or you prepare three different curves. It is up to you. You want to plot the
 <b>area </b>for each.</p>
<p>Lets look at our instrument output.</p>
<p><img src="ChromExample.jpg" width="1632" height="1296"></p>
<p> </p>
<p> </p>
<p>The value that we want to use is in the Area column (fifth from the left).
 The units are in mAU*sec. This is milli-absorbance units and the seconds allows
 up to compensate for the fact that the chromatogram is a signal per unit time.</p>
<p> </p>
<p>When we have constructed our plot our calibration line for caffeine will be
 <font size="+1" color="#008000">Area = Conc + Intercept</font></p>
<p>The intercept should pass very close to zero and if it does then you can most
 likely ignore it. If it is not close to zero see me or your lab instructor.
 Bring along your plot so we can give you advice. For caffeine this data set
 we probably had something close to:</p>
```

```
<p><font size="+3">Area = 3200*Conc.</font></p>
<p> </p>
<p>If we ran a generic sample of Excedrin, prepared as the other samples, and
  got a caffeine peak that was 605.23 then how many milligrams of caffeine would
  be in the generic tablet??</p>
<p>a <a href="flc_hplc6r.htm">605.23 mg</a></p>
<p>b <a href="FLC_HPLC6s.htm">236.4 mg</a></p>
<p>c <a href="FLC_HPLC6t.htm">18.9 mg</a></p>
<p>d <a href="FLC_HPLC6u.htm">2.36 mg</a></p>
<p>Ok you now should be able to determine the amounts of the three ingredients
  in all the types of tablets.</p>
<p> </p>
<p>Go to the next link to get a review on the other calculations that are called
  for in this lab. </p>
<p> </p>
<p><a href="FLC_HPLC7.htm">Go</a></p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6a</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>No, This is the concentration of each of the stock solutions. Remember that
  each will be diluted in the preparation of M0 to M4. </p>
<p> <b>Back</b> button to try again.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6b</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#66FF66" text="#000000">
<p>That's correct! </p>
<p>That will be the concentrations of the the three compounds in this standard
  solution.</p>
<p>Back to continue onto the next topic.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6c</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>This would be the concentration if you use the amounts in an Excedrin tablet.
</p>
<p>Remember you prepared a standard for each compound from pure acetaminophen,
 caffeine and aspirin.</p>
<p>Give it another try.</p>
<p><b>Back</b> button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6d</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>No this is not correct. This would be the concentrations we would have by just
  dissolving one tablet into 100 mL of solvent. </p>
<p>Although we prepared this solution we never inject it.</p>
<p><b>Back</b> button and give it another try.</p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6r</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>This is not correct. 605.23 is just the area. You need to plug it into your
  calibration equation to get the concentration of your injected sample.</p>
<p><b>Back</b> to try another.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6s</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#66FF33" text="#000000">
<p>Yes this is correct. Great job. You took your solution concentration, factored
  back for the 2/25 dilution and then mulitplied by 100 mL to get the total milligrams
  in one tablet.</p>
<p><b>Back</b> and onto the next section</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6t</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>No, you forgot one important operation. Remember that you took a filtered 2.00
  ml of the first solution and diluted it to 25.0 mL. You will need to correct
  you calculation for this dilution. This is done by multiplying by the reciprocal
  of the dilution factor.</p>
<p> </p>
<p><b>Back</b> to try again.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC6u</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>Almost, </p>
<p>This is the answer for the concentration of the sample you analyzed. It will
  be in mg/mL. You need to find the total mg in a tablet. Since the entire tablet
  is dissolved in 100 mL of solution the you need to multiply by the 100 mL to
  factor away this volume. </p>
<p><b>Back</b> and try again. </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC7</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p><img src="ExcedrinHPLC.jpg" width="847" height="929"></p>
<p> </p>
<p> </p>
<p> </p>
<p>From a typical chromatogram let's calculate some of our fundamental
 chromatographic values. </p>
<p> </p>
<p>There is one big caution here - that is that the <b>width</b> on the output
 is the <b>width at half height</b>.</p>
<p>You can also assume that t<sub>m</sub> is 0.615 minutes and the flow rate is
 0.45 mL/min.</p>
<p>The column is 50 mm long and 2.1 mm in diameter.</p>
<p> </p>
<p>What is the plate count for the tallest peak (0.890 minutes)</p>
<table width="30%" border="3">
 <tr>
  <td>
   <div align="center"><a href="flc_hplc7a.htm">5129</a></div>
  </td>
  <td>
   <div align="center"><a href="flc_hplc7b.htm">121</a></div>
  </td>
  <td>
   <div align="center"><a href="FLC_HPLC7b.htm">57.8</a></div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center"><a href="FLC_HPLC7c.htm">321</a></div>
  </td>
  <td>
   <div align="center"><a href="flc_hplc7b.htm">42</a></div>
  </td>
  <td>
   <div align="center"><a href="flc_hplc7d.htm">I don't know</a></div>
  </td>
 </tr>
</table>
<p>What is the resolution between the first two major peaks.</p>
```

```
<table width="30%" border="3">
 <tr>
  <td>
   <div align="center"><a href="FLC_HPLC7e.htm">3.98</a></div>
  </td>
  <td>
   <div align="center"><a href="FLC_HPLC7c.htm">2.34</a></div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center"><a href="flc_HPLC7g.htm">Good</a></div>
  </td>
  <td>
   <div align="center"><a href="flc_hplc7g.htm">Bad</a></div>
  </td>
 </tr>
</table>
<p>What is the relative retention between the first two major peaks.</p>
<table width="30%" border="3">
 <tr>
  <td>
   <div align="center"><a href="flc_hplc7h.htm">1.55</a></div>
  </td>
  <td>
   <div align="center"><a href="flc_hplc7i.htm">2.77</a></div>
  </td>
 </tr>
 <tr>
  <td>
   <div align="center"><a href="flc_hplc7j.htm">0.360</a></div>
  </td>
  <td>
   <div align="center"><a href="flc_hplc7k.htm">1.09</a></div>
  </td>
 </tr>
</table>
<p>What is the capacity factor for the first major peak</p>
<table width="30%" border="3">
 <tr>
  <td>
   <div align="center"><a href="FLC_HPLC7l.htm">1.45</a></div>
  </td>
  <td>
   <div align="center"><a href="FLC_HPLC7m.htm">0.45</a></div>
  </td>
```

```
  </tr>
  <tr>
    <td height="22">
      <div align="center"><a href="FLC_HPLC7n.htm">1</a></div>
    </td>
    <td height="22">
      <div align="center"><a href="FLC_HPLC7o.htm">I don't know</a></div>
    </td>
  </tr>
</table>
<p>How short could this column be and still have a resolution of 1.0 between the
  first two peaks</p>
<table width="30%" border="3">
  <tr>
    <td>
      <div align="center"><a href="FLC_HPLC7p.htm">4.6</a></div>
    </td>
    <td>
      <div align="center"><a href="FLC_HPLC7q.htm">2.14</a></div>
    </td>
  </tr>
  <tr>
    <td>
      <div align="center"><a href="FLC_HPLC7r.htm">0.91</a></div>
    </td>
    <td>
      <div align="center"><a href="FLC_HPLC7s.htm">I don't know</a></div>
    </td>
  </tr>
</table>
<p> </p>
<p> </p>
<p> </p>
<p> </p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC7a</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>You are close. </p>
<p>You are missing a minor point, the width can be measured at two different places.
  Did you use the correct formula for the width you have.</p>
<p><b>Back</b> to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC7b</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>You are close. </p>
<p>Recheck the formula and make sure you plugged in correctly.</p>
<p><b>Back</b> to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC7c</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#66FF33" text="#000000">
<p>OK, Great job! </p>
<p>Use the <b>Back</b> button to return and try the next question.</p>
</body>
</html>
```

```
<html>
<head>
<title>FLC_HPLC7b</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFF99" text="#000000">
<p>This is not that bad. </p>
<p>Recall that the number of plates is a measure of how well a column is able
  to resolve peaks. This a function of the time in the column and how narrow the
  peaks are. Check Chapter 23 in Harrris and find the formula that you need to
  use.</p>
<p><b>Back</b> button to return and give it a shot.</p>
</body>
</html>
```

note: this is the same response as 7b so the same file was used.

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>Not quite. </p>
<p>Recall that you are given the width at half height. </p>
<p>You must adjust for this. You have an equation.</p>
<p><b>Back</b> Button for another try.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3366" text="#000000">
<p>Nice try. </p>
<p>We want to calculate a value so that we can quantify how good or bad a separation
  is.</p>
<p><b>Back</b> Button and give it another try.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>This is one case where we use our adjusted retention time. Did you you that?</p>
<p>Back to try again</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#66FF66" text="#000000">
<p>Yes.</p>
<p>You remembered to adjust for the the dead time.</p>
<p><b>Back</b> to continue to the next question</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFFFF" text="#000000">
<p>Almost, remember that this is always expressed as a number greater than 1.
  .</p>
<p>Go Back to try again.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>No, this is not right.</p>
<p>Be careful - make sure you pick up the correct values. </p>
<p>You have used width not retention time here.</p>
<p>Go <b>Back</b> to try again.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3300" text="#000000">
<p>Don't forget that you need to subtract the time in the mobile phase. </p>
<p>Patch this up and give it another try.</p>
<p><b>Back</b> to question.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3300" text="#000000">
<p>Don't forget that you need to subtract the time in the mobile phase. </p>
<p>Patch this up and give it another try.</p>
<p><b>Back</b> to question.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF0033" text="#000000">
<p>That was just a guess wasn't it. </p>
<p>The capacity factor is an important parameter in chromatography. See Table
  23-2 and/or Equation 23-19 in Harris for some help.</p>
<p><b>Back</b> button and give it another shot.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFF99" text="#000000">
<p>Capacity factor is nothing more than the ratio of the extra time a compound
  spends on the column over the time dead or void time. </p>
<p>The capacity factor is an important parameter in chromatography. See Table
  23-2 and/or Equation 23-19 in Harris for some help.</p>
<p><b>Back</b> button and give it another shot.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>You are very close. </p>
<p>You just dropped one little math operation. Look over your work and give it
  another shot.</p>
<p><b>Back</b> button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FF3333" text="#000000">
<p>You are very close. </p>
<p>Don't forget you have a square root function and you must account for that.
  Review how you would do this and give it another shot..</p>
<p><b>Back</b> button to return.</p>
</body>
</html>
```

```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#66FF33" text="#000000">
<p>Great Job! </p>
<p>You are now done. </p>
<p><a href="http://www.rit.edu/%7Elprsch">Back to my home page</a>.</p>
<p> </p>
<p> </p>
</body>
</html>
```

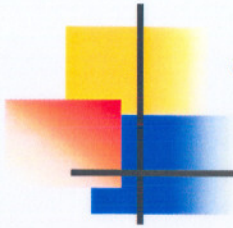
```
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
</head>

<body bgcolor="#FFFF66" text="#000000">
<p>There is a hard way and an easy way to do this problem. </p>
<p>You have an equation for R (Resolution) that involves the Number of Plates,
  the capacity factors and the separations factor. </p>
<p>You could calculate all of these and plug in and get the required number of
  plates (which is directly related to Length). But you should realize that the
  capacity factors and separations factor should be invariant on length. </p>
<p>This allows you to set up a ratio where the ratio of the resolutions equals
  the square root of the ratio of the Lengths, Give it a try.</p>
<p><b>Back</b> button to return.</p>
</body>
```

Faculty Learning Community Project

Web Assisted Programmed Learning to Supplement Laboratory Instruction in Chemical Separations.

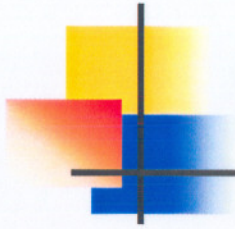
L. Paul Rosenberg

Chemistry Department



The Problem

- Due to limitations of laboratory instrumentation students must rotate through experiments.
- Lab work can be undertaken weeks before lecture coverage.
- There is a wide range of math skills among the students in the course.
- Students have access to text resources and lab manual instructions but many students have a difficult time collecting and organizing all the elements needed to prepare their lab report.
- Large enrollment lab requires significant office hour interaction.



Problem Statement

- Due to limitations of laboratory instrumentation students must rotate through experiments.
- Lab work can be undertaken weeks before lecture coverage.
- There is a wide range of math skills among the students in the course.
- Students have access to text resources and lab manual instructions but many students have a difficult time collecting and organizing all the elements needed to prepare their lab report.
- Large enrollment lab requires significant office hour interaction.

Programmed Learning

- Programmed learning is an older method used to provide immediate feedback to enhance the learning process.
- A wide variety of programmed learning texts were available in print in the past. Such texts presented material, asked questions and from correct or incorrect responses directed the student through the lesson. This was done with much page flipping due to the nature of the printed media.
- Errors in understanding would be addressed based on the provided incorrect responses.
- Although this might not fit all learning styles it can work effectively for some.

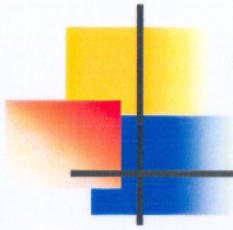
References

- http://www.dushkin.com/connectext/psy/ch06/prolearn.mhtml accessed 1/9/04
- http://www.encyclopedia.com/html/p1/progrins.asp accessed 1/9/04

In print examples (Chemistry)

- Concepts in Organic Chemistry: A Programmed Learning Approach, Peter Simpson, Chapman & Hall, 1st Edition (1994)

- Molecular Symmetry and Group Theory : A Programmed Introduction to Chemical Applications, Alan Vincent, Wiley,2nd Edition
(2001)



The Lab

- High Performance Liquid Chromatography Experiment.
  - Dissolve an Excedrin tablet (or generic equivalent)
  - Dilute to appropriate concentration range
  - Prepare standard curves for the three active ingredients
    - Acetaminophen
    - Caffeine
    - Aspirin
  - Separate the mixture using a reverse phase method.
  - Interpret results and report active ingredient amounts.
  - Calculate fundamental chromatography parameters from the chromatogram.

Lesson Design (html format)

- Detection and data presentation review. (External links provided if needed by the student)
- Data plotting review. (with links to help in Excel if needed)
- Instructions and questions about sample preparation calculations.
- Instructions and questions about dilution calculations.
- Active ingredient determination calculations.
- Parameter calculation practice. (Plates, resolution, scaling etc.)

Sample Question and Responses

If you assume the label claim is correct for caffeine (65 mg) then what is the concentration of caffeine in this second solution.

a) 1.00 mg/mL

b) 0.65 mg/mL

c) 0.052 mg/mL

d) I don't know how to do this calculation.

Response a.

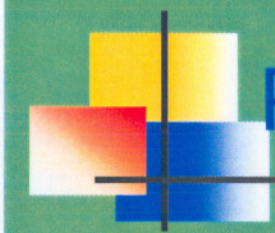
No, that is not correct. Let's think. You first did dissolve the sample in 65 mL but remember that you diluted it up to 100.0 mL. Give the calculation another try.

Back button to return.

Response b.

No, remember to take into account all your steps. You took an aliquot from your solution and then diluted again. Give it another try.

Back button to return.



Response c.

Great!!! That is the correct value!.

Continue with exercise.

Response d.

OK, let's think this over.

You have 65 mg in the entire tablet. This is dissolved into 65 mL of methanol to effect fast dissolution. Then we transfer to this to a 100.0 mL volumetric flask and then fill it to the mark with your aqueous buffer. The concentration now will be the mass over the final volume. The next step is to take 2.00 mL of this solution and dilute to 25.00 mL. This now gives an additional dilution of 2/25.

Hit the **Back** button and give the calculation a try.

Project Evaluation

- Survey of student impressions.
- Assessment of report quality from students.
- Evaluation at the end of spring quarter and with summer quarter students.

Original Proposal Submitted to FLC

Faculty Learning Community Proposal
Winter Development, Spring Delivery
L. Paul Rosenberg

Objective:

Alternate delivery of background material for SCHA312 – Chemical Separations

A medium sized course (~65) with two different student populations. Chemistry majors and biotechnology majors.

Background: Traditionally the background material - math review, basic equilibrium, solvent extraction, counter current systems and fundamental plate theory are taught in the lecture mode. Understanding of this material is important for the remainder of the course. Text coverage is brief so a teacher prepared online chapter is used for the material. My perception is that this material is not learned well and categorized into the learning and forget mode.

Learning strategy. Programmed learning, web based.

Background. Programmed learning has been around for years. Yet a survey of active learning literature shows that there has not been much current application of this method. From personal experience I feel that this is an effective learning tool.

An overview of this method can be found at

http://www.csd.uwa.edu.au/altmodes/of_delivery/programmed_learning.html

This reference points out the advantages and disadvantages of the method.

"

Advantages

- Learning tasks are broken down into manageable chunks
- The learner receives valuable feedback
- The learners can proceed at their own pace

Disadvantages

- Learner has no control over tasks to be undertaken or the sequencing of them
- Based on a view of learning which sees knowledge as comprising aggregates of discrete elements "

An example from the literature was found at

http://fie.engrng.pitt.edu/fie2000/papers/1247.pdf

which is a web based programmed learning exercise in circuit analysis.

Collaborators.

Faculty Reviewer. TBD

Student Reviewer. TBD

Assessment of the effectiveness of the project. Class will be split into two groups. One will receive the traditional lecture; the second group will do the programmed learning exercise.

Evaluation will look at test scores from the two groups in the first hour exam, survey of student iq pressions.

FLC Proposal – As Carried Out
Changes is Italics

Faculty Learning Community Proposal
Winter Development, Spring Delivery
L. Paul Rosenberg

Objective:

Alternate delivery of background material for SCHA312 – Chemical Separations

A medium sized course (~65) with two different student populations. Chemistry majors and biotechnology majors.

Background: Traditionally the background material - math review, basic equilibrium, solvent extraction, counter current systems and fundamental plate theory are taught in the lecture mode. Understanding of this material is important for the remainder of the course. Text coverage is brief so a teacher prepared online chapter is used for the material. My perception is that this material is not learned well and categorized into the learning and forget mode.

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http://fie.engrng.pitt.edu/fie2000/papers/1247.pdf

which is a web based programmed learning exercise in circuit analysis.

FLC Proposal – As Carried Out
Changes is Italics

Collaborators.

Faculty Reviewer. *Laura Tubbs, Professor, Chemistry*

Student Reviewers. *Amanda LoGuidice and Rachel Pleuthner. Chemistry Majors*

Assessment of the effectiveness of the project. *Once coding was started it was obvious that the original plan was too aggressive and to complete on the proposed time line. The project was shifted to the associated lab and was focused on a lab exercise that has always caused significant difficulties for the students. The project was given as a supplementary assignment. Assessment was done during finals as a survey on impressions. I will note that the performance on the lab was much better than in the past.*

Evaluation: *Survey of students.*

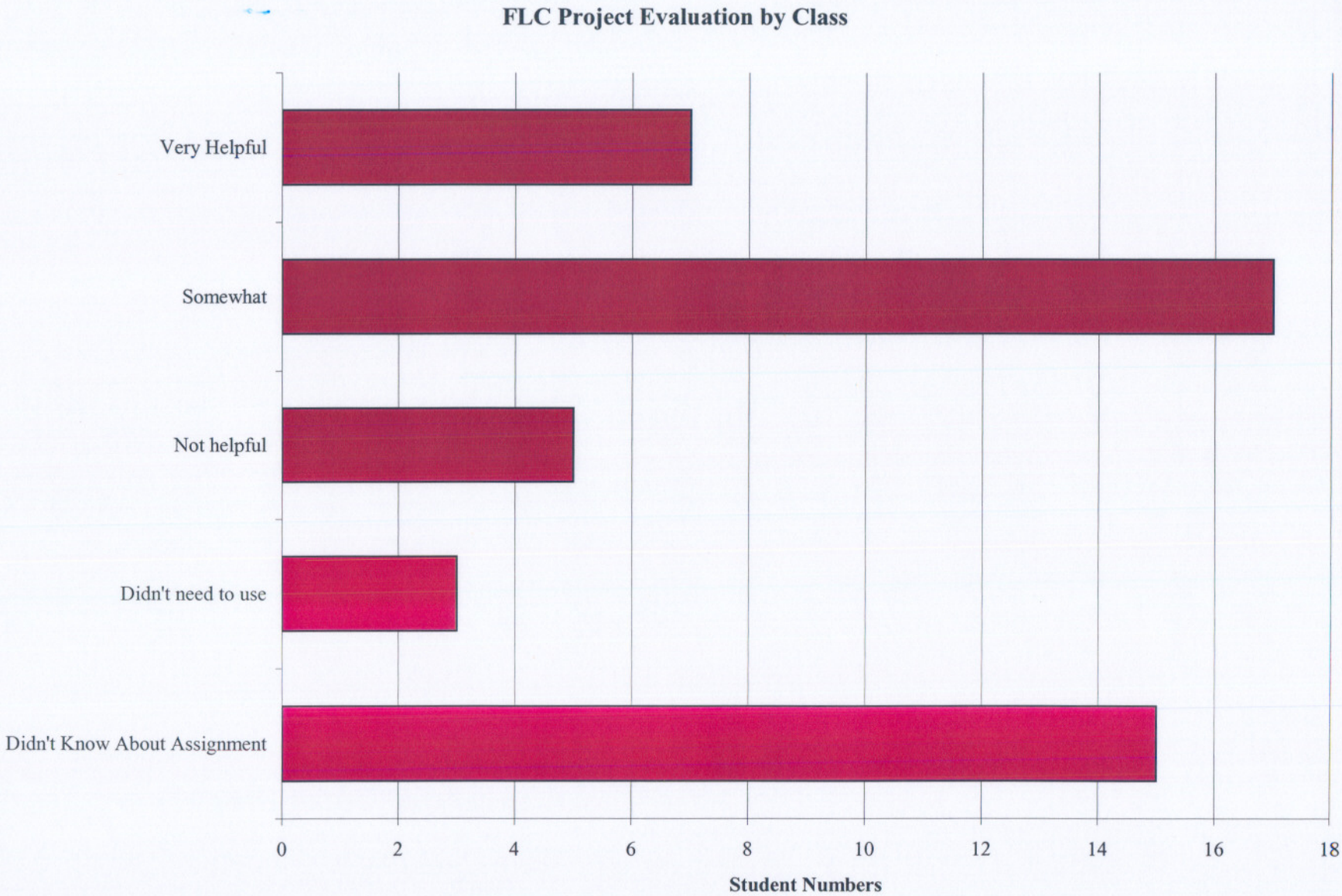
Summary of Programming Learning Exercise
FLC 2003/4

	What did you think about this exercise		Would you use if available for other labs		Format			
Response	#	%	Would use	Would not use	Useful		Confusing	
Didn't Know About Assignment	15	-	10					
Didn't need to use	3	-	1	1				
Not helpful	5	17%	4	1	0	0%	5	100%
Somewhat	17	59%	15	0	9	53%	8	47%
Very Helpful	7	24%	7	0	7	100%	0	0%

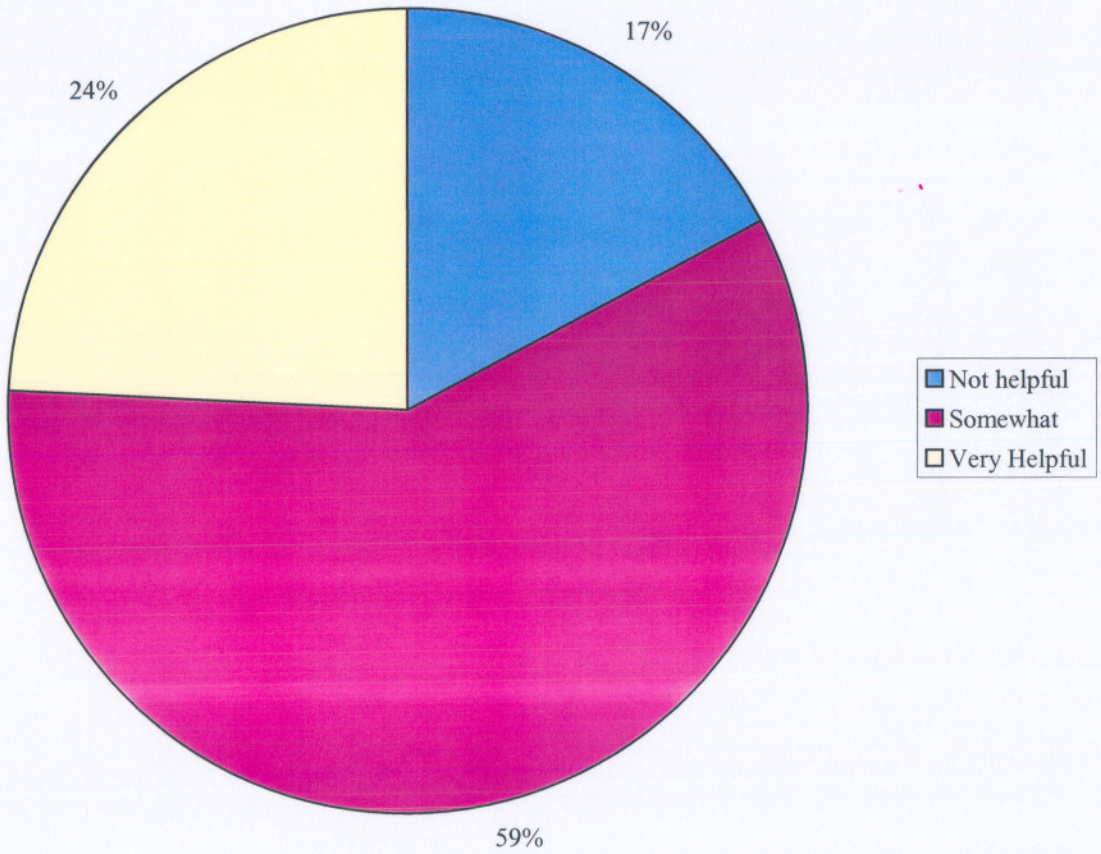
Evaluations Returned	47	
Students that used exercise	29	62%

Percent that would for other labs.	95%
Percent that would not use for other labs.	5%

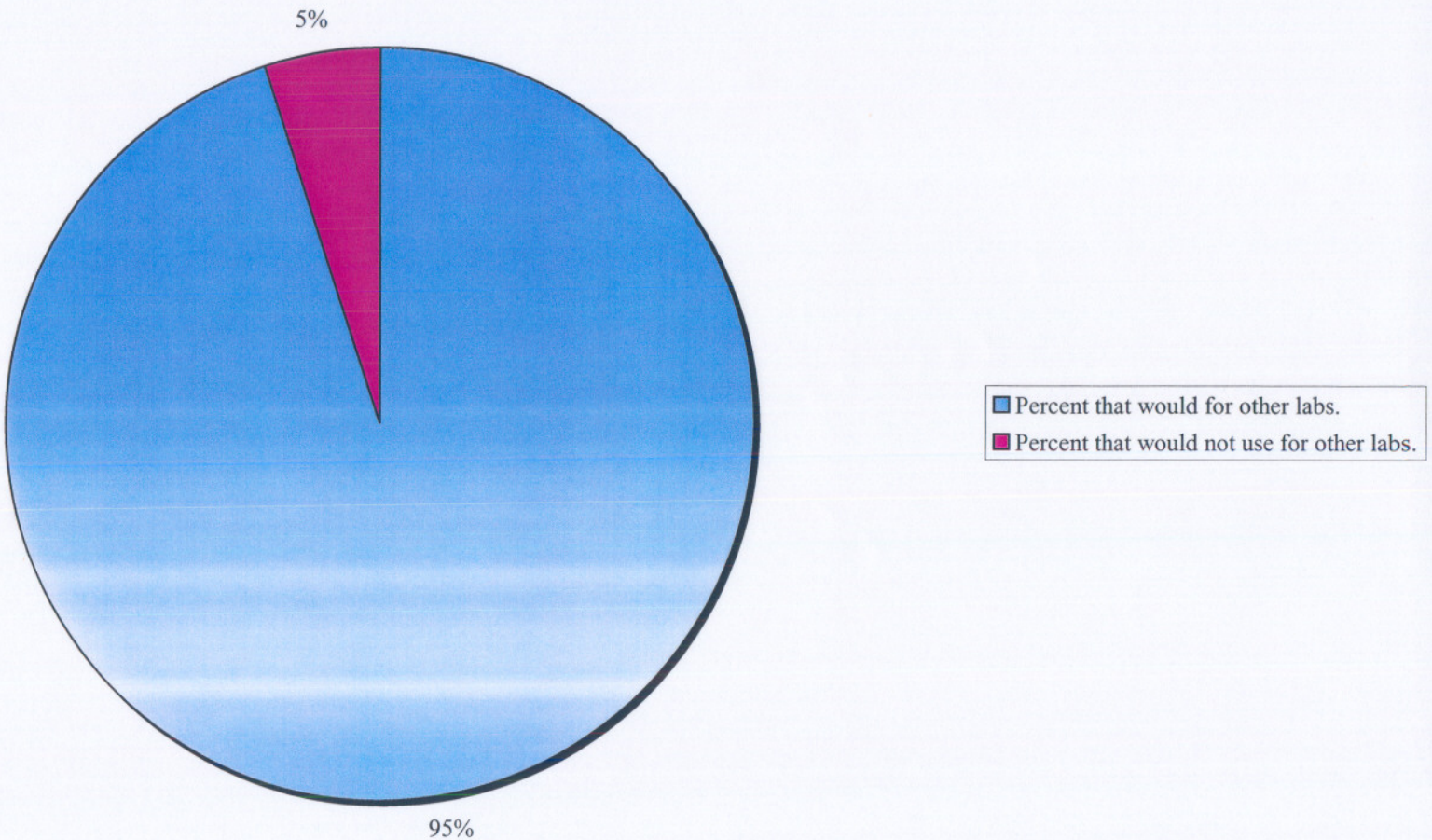
L. P. Rosenberg


FLC Project Evaluation by Class
Very Helpful
Somewhat
Not helpful
Didn't need to use
Didn't Know About Assignment
0
2
4
6
8
10
12
14
16
18
Student Numbers

FLC Project: Evaluation by Users



Willingness to Use for Other Labs



L Paul Rosenberg

From: Amanda LoGuidice [amandabeth33@yahoo.com]
Sent: Tuesday, June 29, 2004 9:03 PM
To: L Paul Rosenberg
Subject: Seps Lab
Follow Up Flag: Follow up
Flag Status: Flagged

Hi Dr. Rosenberg,

I finally got through the HPLC lab for seps. I understood it very well and i thought iwas very well written. I loved the way you did the excericse with the links and the questions and the explanations to why the answers were wrong if they were wrong. I thought this was a great idea.

The only part i found confusing was the calculations. However, this could be becuase i am not in the class or anything. I remember how one lab in quant 2 you outlined how all teh calculations should be done. I remember this helped many students out a great amount. However, the calculations at the end of this lab seem like the students should know them, since you are offering them 4 choices for answers. Overall, i thought it was a very clear lab to understand. I am not sure if this is waht you were looking at for feedback..but let me nkow. Let me know waht i should do next!!!
Thanks

Amanda

amandabeth33@yahoo.com

L Paul Rosenberg

From: Rachel L Pleuthner
Sent: Friday, September 24, 2004 8:10 AM
To: L Paul Rosenberg
Cc: Rachel L Pleuthner
Subject: 1010 480.13

Follow Up Flag: Follow up
Flag Status: Flagged

Hello Dr. Rosenberg,

I just wanted to let you know what I thought of the website for the HPLC lab you asked me to look at; it's really nice. I found it easy to follow, and a good review of the graphing techniques we learned in quantitative analysis. The explanation of HPLC was brief, but gave me a good idea of what it's all about.

I guess that's about it for now. I'll see you again on Tuesday.

-Rachel Pleuthner

(This message is associated with Lab Teaching Experience)

SCHA 312/319 Evaluation Supplement

HPLC Web Supplement (Programmed Learning)

There is a web supplement for working up the data for the HPLC Lab.

a) I did not know this existed

b) I did not need to consult the supplement

c) I went the supplement but did not find it very helpful

(d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

(b) The format was confusing

Would you use similar supplements where they available for other labs?

(a) yes

b) no

Please comment on your impressions on Turnitin.

Good, everyone has to work

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d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes don't know

b) no

Please comment on your impressions on Turnitin.

Stupid, somewhat useless, and tedious

I will not look at these evaluations until the grades are submitted.

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e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

Did not like lab was handed in on time but always forgot about turn it in didnt see the point of it

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Would you use similar supplements where they available for other labs?

a) yes

b) no

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e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

In classes with papers very useful and informative.
In this class: frustrating and a waste of time.

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If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

- Turn it in u a good site, just make all the due dates the date of the final because it messes up dates w/ changing group schedule.

I will not look at these evaluations until the grades are submitted.

Name Graeme Kirkwood (Optional)

SCHA 312/319 Evaluation Supplement

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e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

Very well set up, easy to use.

I will not look at these evaluations until the grades are submitted.

Name Seth Staples (Optional)

SCHA 312/319 Evaluation Supplement

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e) The supplement was very helpful

If you used the supplement

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b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

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e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

I'm impartial. Works well to prevent cheati

I will not look at these evaluations until the grades are submitted.

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b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

No opinion.

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If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

it is a good idea, I wish I could resubmit things a little easier

I will not look at these evaluations until the grades are submitted.

Name Brian Bucher (Optional)

SCHA 312/319 Evaluation Supplement

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c) I went the supplement but did not find it very helpful

d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

Confusing to use. I actually made a quote, but it was marked as plagerism...

I will not look at these evaluations until the grades are submitted.

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SCHA 312/319 Evaluation Supplement

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d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

It seems like a useful tool

I will not look at these evaluations until the grades are submitted.

Name Ami (Optional)

SCHA 312/319 Evaluation Supplement

HPLC Web Supplement (Programmed Learning)

There is a web supplement for working up the data for the HPLC Lab.

a) I did not know this existed

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c) I went the supplement but did not find it very helpful

d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

I don't like it, but I can see the value in it

I will not look at these evaluations until the grades are submitted.

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If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

Interesting, kinda scary @ first though

I will not look at these evaluations until the grades are submitted.

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If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

Seems more relevant for a liberal arts type cours

I will not look at these evaluations until the grades are submitted.

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If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

(b) no

Please comment on your impressions on Turnitin.

Turnitin was way too sensitive. Little things like the headings to the columns of a table came back plagarized.

I will not look at these evaluations until the grades are submitted.

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a) The format was useful

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a) yes

b) no

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e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

I thought it was easy to use & a good way to prevent plagiarism & to keep lab partners from copying or having people make labs or get old reports from other students.

I will not look at these evaluations until the grades are submitted.

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c) I went the supplement but did not find it very helpful

(d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

(a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

(a) yes

b) no

Please comment on your impressions on Turnitin.

I will not look at these evaluations until the grades are submitted.

Name Jadim (Optional)

SCHA 312/319 Evaluation Supplement

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a) I did not know this existed

b) I did not need to consult the supplement

c) I went the supplement but did not find it very helpful

(d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

(a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

(a) yes

b) no

Please comment on your impressions on Turnitin.

I thought Turnitin was hard at some points to submit because on my account it would freeze up.

I will not look at these evaluations until the grades are submitted.

Name _____ (Optional)

SCHA 312/319 Evaluation Supplement

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c) I went the supplement but did not find it very helpful

d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

I like this site very much because it helps you know if you "accidently" plagarized. Makes us more aware and how to better improve our own writing.

I will not look at these evaluations until the grades are submitted.

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(d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

(a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

(a) yes - definately

b) no

Please comment on your impressions on Turnitin.

Seems to cause more hassle than necissary

I will not look at these evaluations until the grades are submitted.

Name Mike Smith (Optional)

SCHA 312/319 Evaluation Supplement

HPLC Web Supplement (Programmed Learning)

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c) I went the supplement but did not find it very helpful

d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

Fast review of lab reports; easy to submit reports on.

I will not look at these evaluations until the grades are submitted.

Name Kacie Allen (Optional)

SCHA 312/319 Evaluation Supplement

HPLC Web Supplement (Programmed Learning)

There is a web supplement for working up the data for the HPLC Lab.

a) I did not know this existed

b) I did not need to consult the supplement

c) I went the supplement but did not find it very helpful

d) I used the supplement and found it somewhat helpful

e) The supplement was very helpful

If you used the supplement

a) The format was useful

b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

It was annoying to remember to turn it in there.

I will not look at these evaluations until the grades are submitted.

Name _____ (Optional)

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b) The format was confusing

Would you use similar supplements where they available for other labs?

a) yes

b) no

Please comment on your impressions on Turnitin.

I'm not a huge fan of Turnitin - too many bugs like comparing your work to itself & giving 100% plagiarism It is a good tool to stop plagiarism in general though!

I will not look at these evaluations until the grades are submitted.

Name _____ (Optional)

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Name _____ (Optional)

Home | Project Info | Resources | Events | Personnel

The POGIL Project

is an NSF funded initiative to support faculty using the POGIL teaching method in their classrooms and labs.

See List of Upcoming Events

POGIL Faculty

- Represent institutions from high schools to research-one universities
- Seek to increase student engagement
- Want students to learn key process skills such as critical thinking and teamwork, along with content knowledge

POGIL Students

- Are actively engaged and thinking in class
- Learn how science is done by analyzing data and drawing conclusions
- Work together in self-managed teams to understand concepts and solve problems

Contact Us

pogil@pogil.org (e-mail) • (717) 358-4639 (tel) • (717) 358-4640 (fax)

Partial support for this work was provided by the National Science Foundation's Course, Curriculum, and Laboratory Improvement Program under grant DUE-0231120

POGIL and the POGIL Project

What is process oriented guided inquiry learning (POGIL)?

POGIL is a classroom and laboratory technique that seeks to simultaneously teach content and key process skills such as the ability to think analytically and work effectively as part of a collaborative team.

A POGIL classroom or lab consists of any number of students working in small groups on specially designed guided inquiry materials. These materials supply students with data or information followed by leading questions designed to guide them toward formulation of their own valid conclusions - essentially a recapitulation of the scientific method. The instructor serves as facilitator, observing and periodically addressing individual and classroom-wide needs.

POGIL is based on research indicating that a) teaching by telling does not work for most students, b) students who are part of an interactive community are more likely to be successful, and c) knowledge is personal; students enjoy themselves more and develop greater ownership over the material when they are given an opportunity to construct their own understanding.

We have found that a discovery-based team environment energizes students and provides instructors with instant and constant feedback about what their students understand and misunderstand. Students quickly pick up the message that logical thinking and teamwork are prized above simply getting "the correct answer." This emphasizes that learning is not a solitary task of memorizing information, but an interactive process of refining one's understanding and developing one's skills.

What is the POGIL Project?

The POGIL Project is a newly-funded NSF project that focuses on the national dissemination of POGIL methods and materials. There are numerous ways for interested faculty to take advantage of the project:

* Attend a 1-3 day regional or national workshop.
* Use tested and commercially available POGIL materials in your classroom, laboratory or recitation session. (General, Organic, and Physical Chemistry materials are currently available.)
* Apply for an on-site consultation in which POGIL experts will help you adapt the POGIL approach to your unique institutional setting.
* Receive support to visit a site currently implementing a POGIL approach.
* Consult with a POGIL expert by phone, web or email.

More experienced practitioners may also:

* Contribute to development of new materials
* Serve as a regional POGIL consultant to provide support to new adopters

Project Goals

In addition to introducing faculty to this new approach to instruction, a key component of the project is the ongoing support given to faculty who are interested in implementing changes. Thus, there are numerous ways for interested faculty to take advantage of this project:

- Workshops on the regional (1 day) and national (3 day) level.
- Materials for use in General, Physical, and Organic Chemistry have been fully developed and tested nationally and are available. These can be used in the classroom, the laboratory, or recitation sessions.
- On-site visits by project experts to assist adopters and potential adopters in the adaptation of the POGIL approach to their unique institutional setting.
- Visits by adopters and potential adopters to sites currently implementing a POGIL approach to observe a typical implementation.
- Consultation by phone or email with a project expert.

An important goal of the project is the development of a network of experts and developing novices that will use the POGIL pedagogy, instruct others in its use, and develop new POGIL materials, both to supplement the currently available materials and to extend the approach to other areas of chemistry.

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ChemActivity 7

Photoelectron Spectroscopy

(What Is Photoelectron Spectroscopy?)

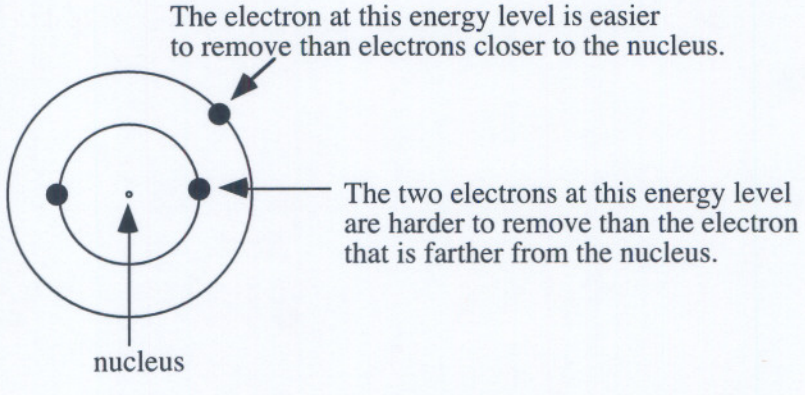
Information

From our previous examination of the ionization energies of the atoms, we proposed a shell model of the atom, and noted that the number of valence electrons in the outermost shell is related to the position of the element in the periodic table, and therefore is an important factor in determining the physical and chemical properties of the element. Within this model, the electrons in an atom are arranged in shells about the nucleus, with the successive shells being farther and farther from the nucleus. The ionization energy described previously is the minimum energy needed to remove an electron from the atom. The most easily removed electron always resides in the valence shell, since that is the shell that is the farthest from the nucleus. For atoms with many electrons, we would expect that the energy needed to remove an electron from an inner shell would be greater than that needed to remove an electron from the valence shell, because an inner shell is closer to the nucleus and is not as fully shielded as the outer valence electrons. Thus, less energy is needed to remove an electron from an $n = 2$ shell than from an $n = 1$ shell, and even less is needed to remove an electron from an $n = 3$ shell. But do all electrons in a given shell require precisely the same energy to be removed? In order to answer this question, we must consider ionization energies in greater detail.

Photoelectron Spectroscopy

From Coulomb's Law, we know that an electron in a given shell will require a certain energy to be separated from the atom. Thus, an electron can be said to occupy an **energy level** in an atom. Within our model, each electron must be in a shell at a particular distance from the nucleus, and the energy levels corresponding to these shells are **quantized**—that is, only certain discrete energy levels should be found.

Figure 1. Each electron within an atom is found at a particular energy level.



Ionization energies may be measured by the electron impact method, in which atoms in the gas phase are bombarded with fast-moving electrons. These experiments give a value for the ionization energy of the electron that is most easily removed from the atom—in other words, the ionization energy for an electron in the highest occupied energy level. An alternative, and generally more accurate, method that provides information on all the occupied energy levels of an atom (that is, the ionization energies of all electrons in the atom) is known as photoelectron spectroscopy; this method uses a photon (a packet of light energy) to knock an electron out of an atom. Electrons obtained in this way are called

photoelectrons.

Very high energy photons, such as very-short-wavelength ultraviolet radiation, or even x-rays, are used in this experiment. The gas phase atoms are irradiated with photons of a particular energy. If the energy of the photon is greater than the energy necessary to remove an electron from the atom, an electron is ejected with the excess energy appearing as kinetic energy, $\frac{1}{2}\ mv^2$, where v is the velocity of the ejected electron. In other words, the speed of the ejected electron depends on how much excess energy it has received. So, if IE is the ionization energy of the electron and KE is the kinetic energy with which it leaves the atom, we have

$$E_{photon} = IE + KE$$

or, upon rearranging the equation,

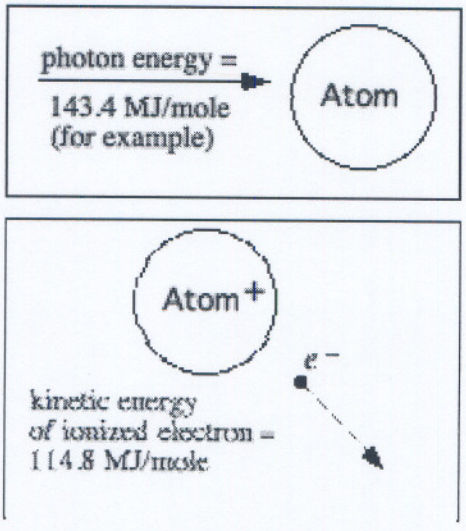
$$IE = E_{photon} - KE$$

Thus, we can find the ionization energy, IE, if we know the energy of the photon and we can measure the kinetic energy of the photoelectron. The kinetic energy of the electrons is measured in a photoelectron spectrometer.

If photons of sufficient energy are used, an electron may be ejected from *any* of the energy levels of an atom. Each atom will eject only one electron, but every electron in each atom has an (approximately) equal chance of being ejected. Thus, for a large group of identical atoms, the electrons ejected will come from all possible energy levels of the atom. Also, because the photons used all have the same energy, electrons ejected from a given energy level will all have the same energy. Only a few different energies of ejected electrons will be obtained, corresponding to the number of energy levels in the atom.

The results of a photoelectron spectroscopy experiment are conveniently presented in a *photoelectron spectrum*. This is essentially a plot of the number of ejected electrons (along the vertical axis) vs. the corresponding ionization energy for the ejected electrons (along the horizontal axis). It is actually the kinetic energy of the ejected electrons that is measured by the photoelectron spectrometer. However, as shown in the equation above, we can obtain the ionization energies of the electrons in the atom from the kinetic energies of the ejected electrons. Because these ionization energies are of most interest to us, a photoelectron spectrum uses the ionization energy as the horizontal axis.

Model 1: Photoelectron Spectroscopy.



IE of electron = 28.6 MJ/mole

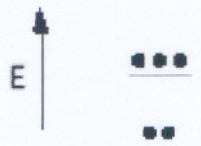
Critical Thinking Questions

1. MShow that the IE of the electron in the model is 28.6 J/mole.

2. What is meant by the term "energy level"?

3. What determines the height (or intensity) of each peak in a photoelectron spectrum?

4. A *hypothetical* atom in a galaxy far, far away has 2 electrons at one energy level and 3 electrons at another energy level (see energy level diagram below).

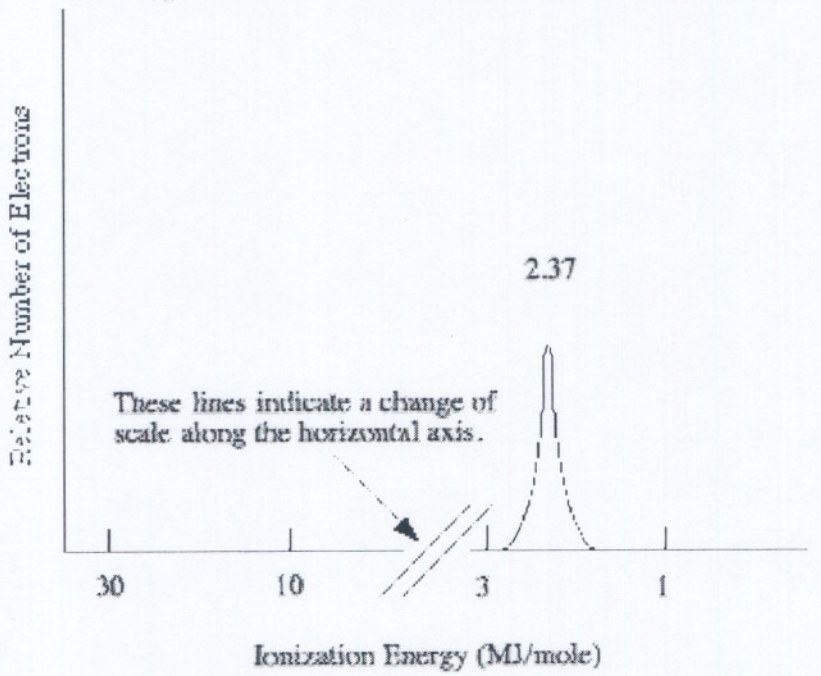


a) How many peaks (1,2,3,4,5) will appear in a photoelectron spectrum of a sample of this hypothetical atom? Why?

b) Describe the relative height of the peaks in the photoelectron spectrum of a sample of this hypothetical atom.

5. What determines the position of each peak (where along the horizontal axis the peak is positioned) in a photoelectron spectrum?

Figure 2. A simulated photoelectron spectrum of an "unknown" atom.



Critical Thinking Questions

6. Based solely on the information in Figure 2, is it possible to determine *how many* electrons are in the $n = 1$ shell of the "unknown" atom? Why or why not?

7. Based on the number of peaks (one) and its intensity in Figure 2 and your understanding of the shell model:

   a) Is it possible to determine if the "unknown" atom is H or He? Explain.

   b) Explain why the "unknown" atom cannot be Li.

8. Based on the value of the IE given in Figure 2, identify the "unknown" atom.

Model 2: The Neon Atom.

Let us now predict what the photoelectron spectrum of Ne will look like, based on our current model of the Ne atom. In this model, there are 2 electrons in the n =1 shell, and 8 electrons in the n = 2 shell of a Ne atom. Assuming that all of the electrons in each of the shells has the same energy, we would expect two peaks in the photoelectron spectrum. One peak, from the electrons in the n = 2 shell, should appear at an energy of 2.08 MJ/mole, because that is the first ionization energy of Ne as determined previously. The second peak should be at a significantly higher energy, because it corresponds to the ejection of electrons from the n = 1 shell, which is significantly closer to the nucleus. At this point we do not have any good way of estimating what that energy is, but we know that it will be a lot higher than 2.08 MJ/mole. Finally, we also can predict the relative sizes of the two peaks—that is, the relative areas under the two curves on the spectrum. Recall that in photoelectron spectroscopy, the bombarding photon ejects an electron *at random* from each of the atoms in the sample. Thus, of the 10 electrons in Ne, we would expect that 2/10 of the time the electron is ejected from the n = 1 shell, and 8/10 of the time it is ejected from the n = 2 shell. The size of the peak in the spectrum is determined by the relative **number** of electrons with that IE that are ejected. Thus, the peak at 2.08 MJ/mole should be 4 times as large as the peak at a much higher energy, which corresponds to the ejection of electrons from the n = 1 shell. *To summarize, our prediction is that the photoelectron spectrum of Ne should consist of two peaks, one at an energy of 2.08 MJ/mole and one at much higher energy, and the relative sizes of these two peaks should be 4:1.*

Critical Thinking Questions

9. Why is it expected that 2/10 of the ejected electrons will come from the n = 1 shell, and 8/10 of the electrons from the n = 2 shell?

10. The peak due to the n = 1 shell is predicted to be at a much higher energy than the n = 2 peak because the n = 1 shell is "significantly closer to the nucleus." Why is the distance of the shell from the nucleus important in determining the corresponding peak position in the photoelectron spectrum?

11. Make a sketch of the predicted photoelectron spectrum of Ne based on the description given above. Indicate the relative intensity (peak size) and positions of the two peaks.

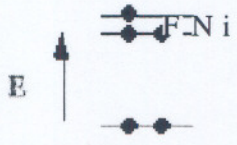
Exercises

1. In a photoelectron spectrum, photons of 165.7 MJ/mole impinge on atoms of a certain element. If the kinetic energy of the ejected electrons is 25.4 MJ/mole, what is the ionization energy of the element?

2. The ionization energy of an electron from the first shell of lithium is 6.26 MJ/mole. The ionization energy of an electron from the second shell of lithium is 0.52 MJ/mole.
   a) Prepare an energy level diagram (similar to the one in CTQ 4) for lithium; include numerical values for the energy levels.

   b) Sketch the photoelectron spectrum for lithium; include the values of the ionization energies.

3. An atom has the electrons in the energy levels as shown below:



Make a sketch of the PES of this element.