Undergraduate Academic Assessment Plan 2012 2013

Chemistry

College of Liberal Arts and Sciences

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Chemistry, College of Liberal Arts and Sciences Undergraduate Academic Assessment Plan

Mission Statement

The Department of Chemistry provides undergraduate chemistry and biochemistry programs equal to or exceeding the caliber of any major US university, as part of the University's stated mission to offer "an educational process that … explores the physical and biological universes and nurtures generations of young people from diverse backgrounds to address the needs of the world's societies," as well as the goal of the College of Liberal Arts and Sciences to provide undergraduate students "an intellectual foundation based on a well-rounded and comprehensive education designed for an increasingly technological and rapidly changing society." Graduates are fully prepared to pursue advanced degrees in chemistry, medicine, dentistry, pharmacy or other related fields or to seek employment in industrial or governmental laboratories. Chemistry majors who also earn the UFTeach science education minor have coursework credentials for high school teaching in a high-demand subject area. Many chemistry and biochemistry majors also include independent study in a faculty member's research group as a component of the undergraduate experience.

Student Learning Outcomes (SLOs)

Existing SLOs for the 2012-13 undergraduate catalog:

Standard Chemistry Track:

1. Knowledge of physical, organic, inorganic and analytical chemistry.
2. Comprehension and use of laboratory skills in synthetic, quantitative and instrumental methods as scientific approaches to gathering and verifying knowledge.
3. Critical thinking in chemistry including interpretation, evaluation, explanation and critical inquiry; how to ask appropriate questions, gather relevant information efficiently and creatively, sort through this information, reason logically from this information and come to reliable and trustworthy conclusions.
4. Ability to collect, analyze and articulate results clearly and effectively in speech and in writing in an acceptable style of presentation.

Biochemistry Track:

1. Knowledge of physical, organic, inorganic, analytical and biochemistry.
2. Comprehension and use of laboratory skills in synthetic, quantitative and instrumental methods as scientific approaches to gathering and verifying knowledge.
3. Mastery of the process of critical inquiry: interpretation, evaluation and explanation. Ask appropriate questions, gather relevant information efficiently and creatively, sort through this information, reason logically from this information and come to reliable and trustworthy conclusions.
4. Ability to collect, analyze and articulate results clearly and effectively in speech and in writing in an acceptable style of presentation.

Revised SLOs for the 2013-14 undergraduate catalog:

Standard Chemistry Track: In the Standard Chemistry Track, students will acquire the knowledge and skills expected of any entry-level professional chemist to:

Content

1. Explain and apply facts, theories, and concepts in (a) physical, (b) organic, (c) inorganic and (d) analytical chemistry.
2. Apply laboratory skills in (a) synthetic, (b) quantitative and (c) instrumental methods as scientific approaches to gathering and verifying knowledge.

Critical Thinking

3. Interpret, evaluate, explain and critically assess theories and experimental results in chemistry.

Communication

4. Collect, analyze and articulate results clearly and effectively in both oral and written formats.

Biochemistry Track: The SLO's are very similar to the above, with the inclusion of additional content needed for an entry-level biochemist (items 1-3).

Content

1. Explain and apply facts, theories, and concepts in (a) physical, (b) organic, (c) inorganic, (d) analytical chemistry, and (e) biochemistry.
2. Apply laboratory skills in (a) synthetic, (b) quantitative, (c) instrumental, and (d) biochemical methods as scientific approaches to gathering and verifying knowledge.

Critical Thinking

3. Interpret, evaluate, explain and critically assess theories and experimental results in biochemistry.

Communication

4. Collect, analyze and articulate results clearly and effectively in both oral and written formats.

Standard Chemistry Track

New/Revised SLOs, 2013-14*	Link to 2011-12*, 2012-13* SLOs
Content	
Explain and apply facts, theories, and concepts in (a) physical, (b) organic, (c) inorganic and (d) analytical chemistry.	Knowledge of physical, organic, inorganic and analytical chemistry.
Apply laboratory skills in (a) synthetic, (b) quantitative and (c) instrumental methods as scientific approaches to gathering and verifying knowledge.	Comprehension and use of laboratory skills in synthetic, quantitative and instrumental methods as scientific approaches to gathering and verifying knowledge.
Critical Thinking	
Interpret, evaluate, explain and critically assess theories and experimental results in chemistry.	Critical thinking in chemistry including interpretation, evaluation, explanation and critical inquiry; how to ask appropriate questions, gather

	relevant information efficiently and creatively, sort through this information, reason logically from this information and come to reliable and trustworthy conclusions.
Communication	
Collect, analyze and articulate results clearly and effectively in both oral and written formats.	Ability to collect, analyze and articulate results clearly and effectively in speech and in writing in an acceptable style of presentation.

Biochemistry Track

New/Revised SLOs, 2013-14*	Link to 2011-12*, 2012-13* SLOs
Content	
Explain and apply facts, theories, and concepts in (a) physical, (b) organic, (c) inorganic , (d) analytical chemistry, and (e) biochemistry.	Knowledge of physical, organic, inorganic, analytical and biochemistry.
Apply laboratory skills in (a) synthetic, (b) quantitative and (c) instrumental methods as scientific approaches to gathering and verifying knowledge.	Comprehension and use of laboratory skills in synthetic, quantitative and instrumental methods as scientific approaches to gathering and verifying knowledge.
Critical Thinking	
Interpret, evaluate, explain and critically assess theories and experimental results in chemistry.	Mastery of the process of critical inquiry: interpretation, evaluation and explanation. Ask appropriate questions, gather relevant information efficiently and creatively, sort through this information, reason logically from this information and come to reliable and trustworthy conclusions.
Communication	
Collect, analyze and articulate results clearly and effectively in both oral and written formats.	Ability to collect, analyze and articulate results clearly and effectively in speech and in writing in an acceptable style of presentation.

Curriculum Map

See page 3 of the "Developing an Undergraduate Academic Assessment Plan" guide.

Curriculum Map for:

Program ________________________ College ________________________

Key: **I**ntroduced **R**einforced **A**ssessed

Standard Chemistry Track

Courses SLOs	CHM 2045 2046	CHM 2212 2213	CHM 3120 4130	CHM 3610	CHM 4411 4412	CHM 2211L	ChM 3120L	CHM 4130L	CHM 4411L	Additional Assessment
Content Knowledge										
#1	I(a,c,d)	I(b)	R(d)	R(c)	R(a)	R(b)	R(d)			DUCK Exam
#2						I,Ap (a)	I,Ap (b) I(c)	R,Ao(c) R (b)	R (b,c)	
Critical Thinking										
#3								I	R	DUCK Exam
Communication										
#4						I	I	R.Ar	R.Ar	

Biochemistry Track:

Courses SLOs	CHM 2045 2046	CHM 2212 2213	CHM 3218	CHM 3120	CHM 3610	ChM 3400	CHM 2211L	CHM 3120L	CHM 4300L	CHM 4413L	Additional Assessment
Content Knowledge											
#1	I(a,c,d)	I(b)	I(e)	R(d)	R(c)	R(a)	R(b)	R(d)	R(e)	R(a)	DUCK Exam
#2							I,Ap(a)	I,Ap(b) I(c)	I(d)	R(b,c)	
Critical Thinking											
#3										R	DUCK Exam
Communication											
#4							I	I		R.Ar	

Symbols: I=Introduced, R=Reinforced, A=Assessed (o=oral tests or reports, r=written reports, p=lab practicals)

Assessment Cycle

Program assessment takes place annually during the Summer B semester using data from graduating seniors, in particular, rubrics for courses designated "A" in the Curriculum Maps, scores on the DUCK exam and written program evaluations from the previous Summer B, Fall, Spring, and Summer A semesters.

Semester, Year in Cycle	DUCK Exit Exam	Student Evaluations	Departmental Action
Summer B, 1	Exam is taken by graduating seniors; results are recorded and saved.	Graduating seniors complete Program Evaluation; forms are collated and saved.	
Fall, 1			
Spring, 1			
Summer A, 1			
Summer B, 2			Evaluation/Corrective Action (see below)

Assessment Cycle Chart

Assessment Cycle for:

Program: Chemistry College of Liberal Arts and Sciences

SLOs / Year	12-13	13-14	14-15	15-16
Content Knowledge				
#1	X	X	X	X
#2	X	X	X	X
Critical Thinking				
#3	X	X	X	X
Communication				
#4	X	X	X	X

Methods and Procedures

Starting in Spring 2008, all graduating seniors have been required to complete a 60-question exit exam, the Diagnostic of Undergraduate Chemistry Knowledge (DUCK), near the end of their final semester. Designed by a team of 15 chemistry faculty for the Examinations Institute of the American Chemical Society, the DUCK tests knowledge across the field of chemistry. Each scenario-based question requires knowledge of more than one chemistry sub-discipline. In addition to having a thorough knowledge of chemistry, students must interpret the data presented in each scenario. As an indirect assessment, graduating seniors also complete a written Exit Survey (attached), including evaluation of required chemistry courses, strengths and weaknesses of the program and faculty, and suggestions for improvement. If known, students also indicate their future career plans.

During the Summer B semester, the chemistry undergraduate coordinators review the collected DUCK results from the previous academic year. If any trends are observed in the types of questions missed, the coordinators notify the corresponding division(s) (physical, analytical, inorganic or organic/biochemistry) that more emphasis is needed on that area. The assessment rubrics for courses designated "A" in the curriculum maps (examples attached) are also examined.

Indirect Assessments

Exit Surveys: Depending on feedback on the student Exit Surveys, the coordinators may also notify the division heads if certain courses do not earn satisfactory ratings from students.

SLO Assessment Matrix 2012 2013

2012 2013 Student Learning Outcome	Assessment Method	Measurement Procedure
SLO 1	Exam	DUCK
SLO 2	Lab practical	rubric
SLO 3	Exam	DUCK
SLO 4	Report	rubric

Assessment Oversight

Name	Department Affiliation	Email Address	Phone Number
J. Eric Enholm, PhD	Professor & Assoc. Chair	enholm@chem.ufl.edu	352-392-0541
Tammy Davidson, PhD	Sr Lecturer & Undergrad Coor	Davidson@chem.ufl.edu	352-392-9134
Kathryn R. Williams, PhD	Scholar Emerita, Undergrad Coor	krw@chem.ufl.edu	352-392-7369

Attachments

Exit Survey

CHM 2211L Lab Practical

CHM 2211L Lab Practical Grading Scale

CHM 3120L Lab Practical and Grading Scale

CHM 4130L Report Grading Scale

CHM4130L Oral Prelab Quiz

CHM 4411L Report Grading Scale

Graduating Chemistry Majors Exit Survey

Congratulations on your upcoming graduation! The Chemistry Department would like to know more about your opinions of our program and your plans beyond UF. Please take a few minutes to complete this survey.

Name:____ Date Completed:____________________

Permanent Contact Address:____

____

Phone:__________________________________ Email:__________________________________

Major (circle one): Standard Chemistry (CY) Biochemistry (CY-BIO)

Double Major in:____

Minor in:____

How would you rate the quality of the following courses (only rate those taken here at UF)?

Course	Excellent	Above Average	Average	Below Average	Poor
CHM 2045					

CHM 2045L					
CHM 2046					
CHM 2046L					
CHM 2210 or 2212 (circle)					
CHM 2211 or 2213 (circle)					
CHM 2211L					
CHM 3120					
CHM 3120L					
CHM 3217					
CHM 3218					
CHM 3400					
CHM 3610					
CHM 4130					
CHM 4130L					
CHM 4302L					
CHM 4411					
CHM 4412					
CHM 4411L or 4413L (circle)					
Other CHM:					

Please explain your future career plans as of today (be as specific as possible):

How would you rate the overall quality of your major program (circle one)?

Excellent Above Average Average Below Average Poor

Please present a general, overall view of the programs strengths and/or weaknesses.

Was there any faculty member in this department who had an exceptional impact on you (either positive or negative) during your time here at UF? If so, please comment.

Do you have any suggestions about ways that we can improve our program? If so, please comment.

____

____

____

Please make any other comments that were not addressed above.

____

____

____

____

Please return your completed survey to Dr. Davidson (Sisler 429 or campus mail). Thank you!

Organic Chemistry Lab Exam/Lab Practical – Practical Portion

CHM 2211L – Summer 2012

Name:____ UF ID:______________________

TA:____ Workstation:_________________

General Instructions:

You have three hours for the experimental portion of this practical. You may not use a calculator or any written materials during this portion of the exam. Please do your own work without consulting the TA proctor or your lab mates. TA proctors will not answer procedural questions or assist you in conducting the experiments.

Melting Point Determination

Obtain an unknown sample from the TA proctor and record the unknown number below. Measure the melting point range for the sample (to one decimal place), and record your melting point data below.

Unknown Number:	**Grading**
Observed mp range:	/5

Aspirin Synthesis

The TA proctor will give you a vial that contains a pre-measured amount of salicylic acid. Record the unknown number in the space below. Prepare a hot water bath (85-95°C) to use during the experiment. Place your salicylic acid in a dry 50 mL Erlenmeyer flask. Add 3 mL of acetic anhydride to the flask, then add 10 drops concentrated H_2SO_4. Swirl well to mix and dissolve the contents, then warm the flask in the hot water bath for 10 minutes, swirling occasionally, to complete the reaction. At the end of the reaction time, allow the flask to cool to room temperature, and then add 15 mL of deionized water to the flask. You will notice an oily product in the bottom of your flask. To induce crystal formation, swirl or stir the mixture – you are trying to keep the oil suspended – then place the flask in an icebath and keep swirling/stirring for a couple of minutes. Leave the flask in the ice bath for 15-20 minutes to complete the crystallization. Be patient! It can take quite a while for crystals to form – if you don't see crystals but still see an oil, use a glass stirring rod to scratch the walls of the flask to induce crystal formation. Collect the crystals by vacuum filtration, and allow the sample to dry on the funnel for about 5 minutes, then transfer the sample to a watchglass to dry in your hood for at least 15 minutes. Place your product in a baggie and staple it to this sheet. **NOTE:** If you spill your sample and need to get a refill, you will receive a grade penalty (-2 points).

Unknown Number:	**Do not write in shaded areas**	**Grading**
	Stockroom measured mass (g):	/10
Staple Baggie with Aspirin Sample Here:	Crystal Quality:	/5
	Refill:	
	TOTAL (Melting Point plus Synthesis)	**/20**

Grading – Lab Practical –CHM2211L-- Summer 2012

Melting Point: The unknown identity is represented by the last two digits in the unknown number. Check to see what values the student reports against the table below:

Number	Range	Grading
01	111-116	**NOTE:** Round reading to nearest whole number, i.e. 115.4 is graded as 115, and 115.5 is graded as 116. • If the reported melting point range falls completely in the
02	111-116	
03	149-154	
04	120-125	

05	124-129	range on the table, then +5 • If the reported range falls partially outside the range on the table, then +4 • If the reported range falls completely outside the range from the table, but by less than 1 degree, then +3 • If the reported range is outside the range from the table by more than 1 degree, then +2 • If range is VERY broad (more than 5 degrees), deduct 1 point from above scores.
06	119-124	
07	134-139	
08	161-166	
09	95-100	
10	137-142	
11	155-160	
12	150-155	
13	108-113	
14	100-105	
15	138-143	
16	114-119	
17	95-100	
18	105-110	
20	114-119	
21	128-133	
22	92-97	
23	119-123	
24	96-101	
25	106-111	
26	156-161	
27	121-126	
28	100-105	

Yield: Use the information below to grade the yield of product.

Range (no label)	Range (with label)	Points	Yield represented
≥ 3.51 g	≥ 3.70 g	+7	> 144%
2.71 – 3.5 g	2.90 – 3.70 g	+8	103-144%
1.45 – 2.7 g	1.64 – 2.89 g	+10	39-103%
1.15 – 1.44 g	1.35 – 1.63 g	+8	23-39%
0.80 – 1.14 g	0.995 – 1.34 g	+7	5-23%
≤ 0.80 g	≤ 0.995 g	+5	< 5%

Crystal Quality:

+5 for dry, good quality crystals

+4 for damp or medium quality crystals

+3 for poor quality, obviously wet crystals

Refill or Late Penalties:

Use -2 for first refill, and -1 for each subsequent refill.

Give -1 penalty if paper is marked late.

TITRATION PRACTICAL, CHM 3120L

(Total Points = 30)

POINTS	STUDENT																					
2	Assemble stopcock																					
2	Remove buret from stand & rinse with 3																					

	small volumes of solution																					
2	Fill buret above zero & remove bubble from tip																					
2	Drain below zero & remove buret from stand																					
2	Read buret and record																					
2	Add indicator																					
3	Titrate w/ large additions at first/Proper hands and swirling																					
3	Smaller additions near endpoint																					
3	Rinse inside of flask																					
3	Fractions of drop (either method) as endpoint is approached																					
3	Judgment of endpoint (record volume & add another drop)																					
3	Record final volume & subtract initial volume																					
30	TOTAL																					

9/15/03

Lab Report Grading Guidelines, CHM 4130L

Liquid Chromatography (125 points total)

I. **Purpose (4 pts)**

+ 2 Study of separation of caffeine, aspartame, and benzoic acid by HPLC; quantitation of the three compounds in diet soft drinks by the external standardization method

+ 2 Determination of MDL for aspartame

II. **Procedure (5 pts)**

+ 2 Instrument models (pump, detector, software)

+ 3 Parameters (mobile phase composition, flow rate, detector wavelength)

III. **Sample Calculations (45 pts)**

+ 2 Calculation of t_R'

+ 3 Calculation of k'

+10 Calculation of concentration of drink component from calibration plot

+ 5 Comparison of result for *Mello Yello* to manufacturer's value or the value from UV experiment (only one sample calculation required)

+10 Calculation of MDL

+10 Calculation of relative sweetness per gram

+ 5 Calculation of relative sweetness per mole

IV. **Data and Results (37 pts)**

+ 4 Table of t_R' and k' data

+10 Table(s) for aspartame, caffeine, and benzoic acid calibration plots

+15 Calibration plots (3)

+ 8 Summary table of soft drink and *Equal* analyses and aspartame MDL

V. **Conclusions (30 pts)**

+ 5 Random Errors (should include some of the following)

Solution preparation

Area measurement

Fluctuations in detector response

Syringe and injector carry-over

Pump fluctuations

+ 5 Systematic Errors (should include some of the following)

Error in concentration of component in the standards--high result if label value is falsely high

Syringe and/or injector carry-over--falsely high peak area if higher concentration is carried over; effect on final result depends on relative effects on standards and unknown

Decrease in flow rate between the standards and the unknown--falsely low result if peaks for the unknown broaden badly

Change in detector response between the standards and the unknown--not much effect because of double beam design

Change in the auto-zero of the integrator between stds and unknown--falsely high result if the true zero voltage increases, because less area is subtracted from peaks for the unknown

+ 5 Discussion of elution orders

At pH 3, the caffeine and benzoic acid are both neutral and the aspartame is –50/50 protonated/zwitterionic (at least in aqueous solution; probably more in the neutral form in the actual mobile phase). On a C_{18} column, nonpolar solutes are preferentially retained. Thus, one might expect the elution order to be: aspartame (partially ionic), caffeine (neutral, but very polar), benzoic acid (neutral with nonpolar benzene ring). However, the phenyl group in aspartame must interact with the stationary phase, because aspartame elutes slightly after caffeine.

+ 5 Minimum soft drink volume

Instead of injecting the filtered, undiluted drink, the sample would be diluted to give concentrations slightly above the MDL's. To determine the minimum volume of drink required, the volume needed for an analysis must be known. Taking injection and filtration into account, about ½ mL for an LC injection (due primarily to filtration losses). (Any reasonable estimate of the total volume needed is acceptable.)

+ 5 Advantages of HPLC

Analysis of several components at the same time; no limitation on number of components as in UV/Vis

Reproducible injection volume

Separation of neutral compounds

Can change mobile phase to improve the separation

+ 5 Limitations of HPLC

Components need to absorb UV/Vis

Ions are not retained unless ion exchange column is used

Single wavelength detection (on this system)

C-18 column has limited pH range

Consumption of large volumes of expensive and toxic solvents

VI. **References (4 pts)**

+ 2 Proper referencing in the text (including reference to the lab manual in the procedure)

+ 2 Proper reference format

9/17/12

Oral Pre-Lab Quiz Suggestions, CHM 4130L

Microchemical Analysis

Note: For items in parentheses, the TA should point to the microscope part.

1. What are the names of (lamp, field diaphragm/iris)? What is the function of the field diaphragm?

2. What is the name of (lower polarizer)? What is the polarization direction?

3. When do you take the upper lens of the substage out of the optical path? What is the name of (stage)?

4. What are the names of (objectives, oculars)? What is the observed magnification if the 40X objective is being used?

5. What do these two knobs do (light path control, upper polarizer insertion)? What is the polarization direction of the upper polarizer.

6. What must be true if a crystal passes light when the upper polar is inserted?

7. What is the name of (objective micrometer)? Describe it. What is it used for?

8. Describe the procedure for the ocular scale calibration.

9. What is the name of the method for determining the refractive index of a solid? Explain

conceptually how it works.

10. Describe the procedure for the Becke test. (Instructor demonstrates test.)

11. Explain how to do the temperature correction for the refractive index.

12. What happens to the Becke line when the oil is a close match to the unknown? Which ways do the colors move?

13. Describe the sodium test. (Instructor demonstrates.)

14. Describe the potassium test. (Instructor demonstrates.)

15. Describe the ammonium test. Why is the ring needed?

16. Describe the nitrate test. What is the solvent?

Grading Sheet for HCl/DCl Experiment, CHM 4411L

Full Report (100 points)

Abstract 3 total

1 Rotation/vibration spectra of HCl & DCl by IR ______________________

1 Anharmonic osc, rigid rotor models w/ Rovib correction _______________

1 Summarize results & isotope effects __________________________________

Introduction 29 total

2 Concept of vibration & rotation ____________________________________

4 Harmonic Osc, Anharm, Rigid rotor, & Combined Rovib eqn __________

____

4 P,Q,R branches & selection rules ___________________________________

4 Derivation of eqns 7 & 8 ____

4 Derivation of eqn 11____

4 Plot & use of eqn 11 ____

4 Isotope effects ____

3 Overall writing quality ____

Procedure 2 total

1 Procedure ____

1 Text ____

Sample Calcs 18 total (v is vbar; B_e is $B_e$bar)

2 Δv(m) ____

2 α_e ____

2 B_e ____

4 I & R_e ____

2 ν_0____

4 ν_0 & B_e Ratios (exp & theo) _____________________________________

2 Text ____

Error Analysis 21 total

4 CI for α_e ____

4 CI for B_e ____

4 CI's for I & R_e ____

4 CI for ν_0 avg ____

4 CI's for ν_0 & B_e Ratios ______________________________________

1 Text ____

Data and Results 14 total

3 Tables of ν(m) ____

6 Graphs ____

2 Summary Table ____

2 Format & SF ____

1 Text ____

Conclusions 10 total

2 Comparison to literature values (using CI's) ______________________

2 Comparison of ratios to theo values ______________________________

4 Intensity pattern ____

2 Error sources & suggestions __________________________________

References 3 total

2 Proper citations throughout _____________________________________

1 Format ____