Departmental and Program Assessment
Annual Assessment Plan Report

Academic Year: **2005-06 Update 21 August 2006**

Academic Department or Program: **Chemistry**

Chair: **M. Warfield Teague**

Describe any changes in the Assessment Plan that have been made during this academic year. (If changes have been made, please submit an electronic copy of the revised Assessment Plan to Amanda Hurd.)

No changes have been made to the Assessment Plan this year.

Describe what *direct* assessment data in your plan have been collected for the year and which have not. ["Direct" refers to evaluated student work.]

All direct assessment data in our plan have been collected this year. This includes graded exams, papers, and laboratory reports; directed research papers and presentations; senior comprehensive examination papers and oral presentations; the Major Field Test in Chemistry with national standardized norm data; and graduate/professional school admission data. Material from individual courses, labs, and directed research are kept by the course instructors; senior comprehensive materials are retained by the department chair. Dr. Kopper has collected and summarized results of the MFT exams for chemistry majors over the past few years (Appendix A). Dr. Hales has compiled a list of as the current situations of our 2006 graduates (Appendix B).

Describe what *indirect* assessment data in your plan have been collected for the year and which have not. ["Indirect" refers to student surveys or opinions.]

All indirect assessment data in our plan have been collected this year. This includes course evaluations of all courses by all faculty. Dr. Gron has collected and analyzed student attitude surveys, lab practical scores, and written exam scores from General Chemistry labs; results of her efforts are summarized in an attached document (Appendix D).

Briefly describe how assessment data have been part of department/program discussions and meetings this academic year.

There was a thorough discussion of the assessment methods when the department evaluated the students in May prior to the Awards Convocation and also soon afterwards in determining the Comprehensive Examination grades prior to graduation

Assessment in general was a topic of discussion at a departmental meeting on 9 August 2006. It was decided that there would be no major changes in the assessment data sets, although more systematic methods will be used in the some of the courses. Thorough course and laboratory assessment programs are used in several courses in the Chemistry Department, particularly General Chemistry (see above) and Advanced Techniques in Experimental Chemistry (ATEC). Attached are two documents describing these assessment programs (Appendixes D and C).

Also, many of the chemistry faculty use American Chemical Society (ACS) standardized examinations to evaluate both the student achievement levels and the effectiveness of the courses measured against the ACS standards. These courses include General Chemistry, Organic Chemistry, Physical Chemistry, Advanced Analytical Chemistry, and Advanced Inorganic Chemistry.

Describe any curricular or other programmatic changes that have been made that were based (at least in part) on the availability of your assessment data.

No major changes were made this year in our program or curriculum. We will use the current assessment data from General Chemistry and ATEC to guide improvement measures for those labs.

Attachments:

Appendix A: MFT Scores
Appendix B: 2006 Graduate Longitudinal Tracking
Appendix C: Assessment of ATEC
Appendix D: Assessment of General Chemistry Labs

Appendix A:
Chemistry Department MFT Scores Summary

Year	Hendrix scaled score mean	# Hendrix Students	Hendrix national %ile	Total # of institutions	Institutional scale score mean	Comments
2006	167.4	11	95+	185	146.9	2>95%, 0<60%
2005	162.5	11	90+	163	147.0	3>95%
2004	165.2	14	95+	117	147.3	4>95%, 0<65%
2003	157.5	11	88	40	146.3	
2002	163.5	10	99	168	146.0	1>99%
2001	157.3	16	91	168	146.0	
2000	159.9	14	95	127	146.3	1>99%

Appendix B:
Longitudinal Tracking of 2006 Chemistry Majors

Last Name	First Name	Year Off?	Employment	School	Program	Location
Eggert	Mindy			Med school	MD	UAMS
Herrold	Jeff	5th yr HC		Med school	MD	UAMS
Kmiec	Kevin			Grad school	PhD	Texas A&M
Le	Steven					
Merritt	Jennifer			Grad school	PhD	Vanderbilt
Mills	Catrin					
Moore	Austin		Pharm rep			
Patel	Janak					
Riem	Renee			Grad school	MS	UAF
Rogers	Courtney			Grad school	PhD	Stanford
Vora	Devang			Med school	MD	UAMS
Alexander	Robert			Grad courses		
Beyga	Roman			Grad courses		
Gray	John			Med school	MD	UAMS
House	Sam			Med school	MD	UAMS

Appendix C:
ATEC Assessment

During the last decade, the Chemistry department has created an integrated laboratory program for upper-class chemistry majors as a bridge between teaching laboratories and faculty-directed student research experiences. Advanced Techniques in Experimental Chemistry (ATEC) combines the traditional laboratories of Physical Chemistry I & II, Advanced Inorganic Chemistry, and Advanced Analytical Chemistry into an integrated, task-oriented, and research-rich experience. The students engage in experiment design, synthesis, characterization, data assessment, and reporting the results. The year-long experience culminates in a six-week practicum known as the Individual Research Initiative (IRI).

ATEC is designed to ingrain the skills for doing research by developing student thinking that is intellectually similar to the creativity and rigor required of the research experience. The learning goals for this junior-level laboratory are

- to develop synthesis, characterization, and analytical skills;
- to improve creative and critical thinking skills;
- to evaluate appropriate techniques and execute a plan;
- to participate in collaborative efforts that transcend traditional scientific divisions;
- to assess the implications of the work and the impact it has on the environment; and
- to strengthen oral and written communication skills.

ATEC Assessment & Evaluation

Introduction and implementation of ATEC at Hendrix College was a major curricular change. As a formative measure of the course, we have assessed the student achievement on the IRI projects. Table 1 includes a list of the graded IRI skills and the % of the available points earned by our students in the years 2004-2006. These skills reflect the learning goals that we set out for the program. As we had hoped, students were very successful in creating, executing and reporting their IRI's, earning over 84 % of the available points. Within the subsections, students did very well with the concept portion of the IRI (89 % overall for this section), probably due to the required meetings and deadlines set by the faculty. The students were also effective at reporting their results in writing (85 %). The outlier within the formal write-up skill set

Table 1. IRI Grading Key and Student Success 2004-2006

IRI Skills	Possible Points Earned by Students (%) 2004	2005	2006	Average %
Concept (30 pts)				
Originality	89	81	93	88
Approach	91	93	88	91
Research	89	94	78	88
Experimental (60 pts)				
Notebook	89	87	88	88
Procedure	87	96	80	88
Data analysis & calculations	84	84	85	84
Results	83	77	77	79
Uncertainty calculation	64	54	67	62
Formal Write-up (60 pts)				
Introduction	100	100	80	94
Theory	79	73	63	72
Experimental	93	89	90	91
Discussion (including error analysis)	87	79	77	81
Writing and organization	93	90	86	90
Average IRI Score, % (150 pts)	86	84	81	84

was the grade for presenting the theory (72 %). The low scores reflected that some students took the ATEC course as a precursor to the theory courses (Advanced Analytical and Advanced Inorganic Chemistry) rather than taking them as pre-requisites or co-requisites. Within the experimental section, the students performed best in the areas where they had the most practice within past tasks, including notebook, procedure, and data analysis and calculations. In the experimental work, we found an anticipated low grade of 79 % for the results since managing an independent laboratory project was still a challenge to the students. The disappointing result was the low score (63 %) in the uncertainty calculations. Discussions with students indicated that these calculations were often left to the last minute and therefore not given the attention that the faculty felt they required. We are developing documents and procedures to address this.

As we had intended, this program has proven effective for breaking down compartmentalization of the material in the chemistry curriculum and providing a bridge to the independence required in faculty-directed research. Our evaluation of the ATEC program has also been borne out in the comments from students on our assessment tool. The major themes of the student comments have been captured in Table 2.

In ATEC, students often learn a valuable lesson associated with research – that successful results are not guaranteed – because instructions for the tasks are not clearly detailed. Instructions in literature references, equipment manuals, and textbooks are not always definitive, leading to negative results during the first attempt and requiring repetition and modification for success. This leads to a major asset of the ATEC program, the strength of the students' problem solving skills.

ATEC has been a positive addition to our curriculum. It fills an important niche, vacant in most undergraduate curricula, by teaching students experimental design, thus preparing them for faculty-sponsored research and real-world problems.

Table 2. Selected ATEC Student Evaluation Comments

Comments from students on the following topics:

Number of tasks:

- There are a reasonable number, and they are demanding at just the right level, so that I do not stress out and I feel I learn something.
- The number of tasks is the perfect amount. I feel if we had more to do it would be too stressful and precautions in lab that are afforded by the time allowed would be overlooked.

Choice of labs (variety, range, etc.):

- Of the pre-selected labs, I wish we had more personal choice of those. (There are some labs that others are doing that I'd like to do, but will never get a chance.)
- Good variety: some synthesis & characterization, some determination of physical properties of molecules, and some trace analysis. Good introduction to some of the major fields in chemistry.
- Not enough P Chem. Too much synthesis.

Level of difficulty (adequacy of background, briefings, pre-lab instructions, instructions, instructor expectations):

- The labs are difficult in the fact that they are not "cook-book" chemistry. One does not approach these labs with the expectation that they will be completed at the end of the period. One genuinely has to learn and understand what is happening in an ATEC lab.
- Appropriate for Advanced Lab. Perhaps instructors should give clearer instructions.

Reports (instructions, length, etc):

- Of course I like the short reports most but the formal reports are [a] very nice learning opportunity. I feel that formal reports should be a part of lower level chemistry labs.
- Formal reports are tedious, but it is valuable to learn the style, especially if one wishes to pursue chemistry.
- Brief reports are better than formal reports. Would rather have three brief than one brief and one formal.
- I wish that the formal reports had been introduced sooner in the chem department. I know they are important, but you can't be good without practice.

Grading:

- Slow, but fair.

Instructor interaction (level, amount, availability, civility, etc.):

- The instructors are highly involved in ATEC. They act as collaborators and advisors more than teachers.
- The instructors were always helpful, but made sure to lead the student to the solution by their own logic skills and not by simply providing the answers.

IRI (instructions, availability of resources, time available, etc.):

- I enjoy being able to take my own initiative and do a project that I choose.
- I dread it and wish I had more direction.

Appendix D:
Assessment in the General Chemistry Laboratory (*Green*-SWAT program)

In the last five years, the Hendrix College chemistry department has been developing a new first-year laboratory program known as Green-Soil and Water Analysis at Toad Suck, (Green-SWAT) *(1)*. The experiments in the Green-SWAT program teach first-year chemistry students green, analytical chemistry using environmental samples within the context of the traditional science majors' chemistry course sequence.

Assessment Plan: Initial assessment of this program has focused on student attainment of analytical laboratory skills. In order to prove that this new program was rigorous, we evaluate analytical skills through two sets of student laboratory data representing precision and accuracy from a four-week iron project (two different but closely related experiments) in the fall semester as well as a laboratory practical administered at the end of the semester. Two other assessment tools, a SALG survey *(2)* and a written exam, further evaluated the students' understanding of analytical work and provided feedback on the other learning goals. Table 1 correlates learning goals and the assessment tools

Table 1. Learning goals and connections to assessment tools.

Learning Goals & Assessment Tools	Accuracy & Precision Data	SALG*	Written Exam	Laboratory Practical
Quantitatively transfer solids and liquids	√	√	√	√
Create analytical solutions (volumetric flasks, pipets and burets)	√	√	√	√
Use a Spec20 (with basic instructions)	√	√		√
Use EXCEL manage numbers, graph & linear regression	√	√		
Use calibrations curves	√	√	√	
Use basic statistics		√	√	
Understand spectroscopy		√	√	
Know environmental action of ions		√	√	
Define and explain green chemistry		√	√	

*Student Assessment of Learning Gains (SALG) adapted from work by Elaine Seymour http://www.wcer.wisc.edu/salgains/instructor/SALGains.asp#intro (accessed August 2006)

used to date.

Project Assessment and Evaluation

Table 2 lists the precision data collected in the fall of 2004 and 2005 for the two experiments in this project, UV-Vis and FAA spectroscopy. The precision was assessed by the % relative error of the slope of student generated calibration curves[i]. Inspection of the data indicates that the students in both years and in both experiments were successful in creating high quality calibration curves. Within the UV-Vis data, students in 2005 were significantly better able to prepare standard curves with low error compared to the 2004 class. This is particularly gratifying since the number of students in the 2005 sample was much larger with multiple faculty participating in the program. The apparent shift in the FAA data to slightly low precision is not significant based on a chi-squared analysis[ii].

In addition to collecting precision data, we assessed student accuracy in the FAA experiment. As part of the experiment, students prepared a standard unknown, unknown to the students, but known to the teaching staff. Our expectations of accuracy for first semester chemists are limited. Our goal is to have the majority of the students attain errors of less than 15 %[iii]. The FAA accuracy results collected in Table 3 show that a respectable number of students, 69 % and 60 % in 2004 and 2005, respectively, were within 15% error. The differences in the data from 2004 to 2005 were found to be significant ($\chi^2_{.05}$ (3 *df*) = 8.15) and primarily due to the increase in students with error > 20 %. We were puzzled by this due to the excellent precision obtained in the same experiment by the same students. We presume that the problem lay in the difference between making solutions versus preparing the solid standard unknown.

Table 2. Trends in Student Laboratory Precision in the Fall of 2004 and Fall of 2005

Student Precision[a]	UV 2004	UV 2005	FAA 2004	FAA 2005
<1 %	6	44	6	5
1 - 2 %	47	21	31	16
2 - 5 %	24	21	63	71
5-10 %	12	12	0	5
10 - 15 %	6	2	0	5
> 15 %	6	0	0	0
n[b]	17	43	16	44

a. Measure as % relative error of the slope (e_m/m %)
b. n = number of student groups

Table 3. Student Accuracy Results

% Error[a]	% Students 2004	2005
< 10%	38	39
10%-15%	31	21
15-20 %	13	7
20 + %	19	34
n[b]	16	44

a. Measure as % relative error between the known value the student answer.
b. n = number of student groups

The laboratory practical was designed to evaluate the students' ability to create standard solutions from a solid, mimicking the skills needed to prepare the standard unknown. Students were given brief written instructions for creating a copper nitrate solution using ~1 g of solid and measuring the absorbance on a spectrophotometer. Faculty and staff graded students' actions using a simple rubric that broke down the activity into 14 individual tasks. Table 4 lists the skills and the % of students successfully completing each skill as well as the average accuracy attained by the students. The results indicate that the students can do a number of things extremely well. On average, 92(±11) %[iv] of the students could successfully execute the skills. However, Table 4 also highlights two skills that fell well below the average. These are subtracting the final weight of the paper and quantitatively transferring from the mixing container, item numbers 3, and 6. These two skills were unique to working with a solid rather than diluting solutions from a stock, indicating that these errors in the laboratory were resulted in the accuracy errors in quantitative handling of the solid.

By designing a practical to assess solution making techniques from solids, we were able to uncover that our students had no overt instruction on quantitative transfer. This error in quantitative transfer was uniquely problematic for the solid standard unknown in the FAA experiment. We have taken steps to teach quantitative transfer in our fall laboratory program and anticipate that the accuracy scores will increase as a result of that.

Table 4. Laboratory Practical Skills and Student Success

Laboratory Skill	Item No.	% Students Successfully Completed
Balance Use		
Tare weighing paper	1	94
Subtract final weight of paper	3	69
Transfer Skills		
Transfer directly to mixing container	4	97
Dissolve completely	5	98
Quantitatively transfer to volumetric	6	69
Volumetric glassware use		
Fill to mark	7	98
Invert 15-20 times using parafilm	8	96
Spectrometer Use		
Align cuvette	9	96
Wipe cuvette	10	100
Rinse cuvette	11	99
Blank spec 20	12	99
Record measurements	13	95
Calculation	14	100
Accuracy		77

Literature Cited

1. *Toad Suck is the colorful and historically correct name for the Arkansas River Crossing closest to Conway, Arkansas.*
2. *Green chemistry is the design of environmentally-benign processes and products by the reduction or elimination of hazardous materials and wastes.*

Notes:

1. Precision was evaluated as the relative error of the slope of the calibration curve (e_m/m %) where e_m, error of the slope, was calculated by the LINEST function in EXCEL.
2. $\chi^2_{.05}$ (5 *df*) = 3.78.
3. Accuracy was evaluated as the % error between the % iron in the solid standard unknown (reference material) and the % iron calculated from the absorptivity (A) of the students' solution and a faculty generated calibration curve. The error reported is the standard deviation of the mean multiplied by $t_{n=15}$.
4. The error reported is the standard deviation.

HENDRIX

Grant Report for Year One

A Proposal to Strengthen the Physical Sciences at Hendrix College through Research and Recruitment

I. Overview

In May 2004 Hendrix College received a special grant from Research Corporation to "Strengthen the Physical Sciences at Hendrix College through Research and Recruitment." The grant funded the Hendrix Advancement of Research in the Physical Sciences (HARPS) program on campus. The HARPS program includes two major initiatives. The first is to increase research strength in the physical sciences through targeted funding of equipment that expands research opportunities directed by the chemistry and physics faculty. The second initiative is a collaborative effort among the chemistry and physics departments with the Office of Admission to develop programs that increase the number of participating students at the introductory level in the physical sciences. There are three attachments added to this report that should reflect the research productivity of the Chemistry and Physics faculty since 1994. These are Appendix A (Publications in the Chemistry and Physics Departments from 1994), Appendix B (Grants and Pending Proposals since 1994), and Appendix C (Student Presentations in the Chemistry and Physics Departments, 2000-2005).

II. Research Specifics

A. Laser Initiative

1. Basic Laser Research

As proposed by Bob Dunn in the HARPS application, the Hendrix College Ring Laser in the basement of the Morgan Science Center has been upgraded and is currently taking data. It uses a triangular configuration with a perimeter of 45 meters. In the process of verifying its operation a very low frequency in the mHz (millihertz) regime, that apparently corresponds to the Earth's spheroidal fundamental modes, was detected. Because of the seismological and geophysical interest in this area, it was initially decided to concentrate on trying to understand the source of these signals before proceeding with an investigation of the split longitudinal mode operation.

Concurrently, work is progressing on the NSF-MRI project and hopefully it will be operational in a couple of months. The project was significantly delayed when the principal investigator suffered a knee injury that required surgery. The device under construction is similar to the ring laser in the Morgan Science Center but has a perimeter of 165 meters. The increased size should greatly increase its sensitivity and the remote location should reduce extraneous noise.

Funding for the upgrade to the laser in the Morgan Center was obtained from the match required under the HARPS award. The funds directly from Research Corporation will be used to study the novel split longitudinal mode operation in ring lasers. They will also be used to examine the possibility of using an extended cavity laser diode as an excitation source for large ring lasers that operate in a split longitudinal mode configuration. The goal is to demonstrate that the split mode regime of operation significantly reduces the cross coupling between the counter propagating beams in a ring laser. If the coupling is sufficiently reduced, it may permit bi-directional operation in a strongly homogeneously broadened medium, such as found in laser diodes.

2. Laser Applications

The excimer laser discussed in the original proposal has been purchased and is living up to all performance expectations at both 193 and 248 nm. Initial experiments by the Hales research group focused on elucidation of the neutral B_nBr_m species emitted from the pulsed discharge ion source, as described in the HARPS proposal, but no satisfactory results were obtained. The reason is not yet clear, and the effort will be revisited when proper parameters for laser timing and alignment are more firmly established.

Subsequently, photoionization studies of clusters of both styrene and phenylacetylene molecules were undertaken. An alternation in intensity of $(\text{styrene})_n^+$ cluster ions has been observed, where clusters with even *n* are more intense than their neighbors with odd *n*. No such alternation was observed with phenylacetylene. This phenomenon has been observed previously with styrene, and structures of the cluster ions have been proposed. The styrene clusters are being probed by two experimental methods. 1) Metastable fragmentation occurs when ions have enough internal energy to dissociate, but do so slowly enough that they survive until they have been fully accelerated into the field-free region of the time-of-flight mass spectrometer. The reflectron acts as a kinetic energy filter to separate daughter (fragment) ions from their parent cluster ions, and it is possible to identify the fragments by mass. Thus, the effect of just the small amount of excess energy left over from the two-photon ionization process can be determined. 2) Studies utilizing photodissociation of mass-selected cluster ions as a probe of their structure are also in progress. This is very similar to the metastable fragmentation experiment, but with the addition of a second laser pulse to excite the cluster ions after mass selection. A limited set of wavelengths (Nd:YAG and harmonics: 1064, 532, 355, and 266 nm) is presently available, and definitive data has not yet been generated. In an approach meant to complement experiments, the structures proposed in the literature and some other possible structures have been modeled at the B3LYP/6-31G* level. The structures proposed earlier are not predicted to be the lowest energy structures, so it seems reasonably likely that the fragmentation data will be consistent with a different cluster structure motif.

B. Liquid separations Initiative

This grant purchased a Dionex Summit High Performance Liquid Chromatography (HPLC) gradient system, which provides the chemistry department with much needed capabilities for the separation of thermally fragile organic molecules. This instrument provides support for the organic and biochemical research in the department.

1. Chemistry in Hot Water Liz Gron's research has focused on developing Diels-Alder (DA) reactions in high temperature water (HTW; T > 100 °C and P > 1 bar) in order to develop a mechanistic view of the effect of water and to create green reaction systems. In the past year, her proposal was funded by an ACS-PRF type B research award ($50,000) for "*Green Chemistry: Diels-Alder Reactions in High Temperature Water.*" This grant supports the summer researchers and the purchase of a second reaction system. Additional support has included two small internal research awards known as Odyssey grants ($8,400).

Initially, we focused on the dimerization of cyclopentadiene (CP). Although good kinetic data were obtained at low temperatures (< 100 °C), it became apparent that CP was too volatile for use in our reactor system at higher temperatures. Despite our best efforts, it was impossible to empty the reactor fast enough to prevent gas phase CP dimerizations from contaminating the desired homogeneous aqueous-phase kinetic data. In order to further study the dimerization of CP, a quencher will be necessary or a new apparatus will have to be designed that can monitor the chemicals *in situ*. It is expected that the Dionex Summit HPLC system will be of great service when we return to this system.

Present work focuses on the DA reaction of N-ethylmaleimide (MAL) with 9-methanol anthracene (AN). These chemicals have the benefit of high boiling points, well above 100 °C, in conjunction with an established kinetic literature, both experimental and computational. This summer we have created quantitation methods for the GC/MS and UV-Vis; however, new methods created with the recently installed HPLC seem to have a much larger dynamic range with higher sensitivity. The HPLC is being used in the reverse-phase (RP-HPLC) allowing all the species in solution can be independently identified. This new capability broadens our options for collecting kinetic data by reducing the quantification steps, thus improving the quality of our data. At present, we run the kinetics on a pseudo first-order system by using an excess of MAL; however, it is possible that we might be able to measure all components directly with the new HPLC.

During the summer of 2005, we have synthesized the MAL-AN adduct in order to independently identify the product, and to assure a closed mass balance. This will also allow us to study the reverse Diels-Alder (RDA) reactions that should yield insight on the extent of H-bonding since the change in the hydrophobic surface area from the reactants to the transition state is negligible.

Beyond Diels-Alder reactions, we have begun to develop other solvent accelerated systems for use in HTW. These systems include Beckmann rearrangement of the cyclohexanone-oxime system. This system has been studied in HTW before, but it is probable that the data gathered had problems with water loading at sub-critical temperatures.

Four undergraduate students worked on this project during the academic year and all presented at the national American Chemical Society meeting. One student worked with the PI during the summer of 2004 and two worked during the summer of 2005.

2. Other Separations Research at Hendrix College

Tom Goodwin's major research project is centered around a search for chemical signals (pheromones) in African elephants. In the past, his group identified some novel compounds by GC-MS in temporal gland secretion, then verified them by total synthesis (published in the *Journal of Natural Products* in 2002). Tom also has an ongoing project on the synthesis of analogues of the anti-cancer compound lamellarin, a polycyclic pyrrole-containing marine natural product. The HPLC may prove to be useful in separating complex mixtures resulting from either project, whenever flash chromatography is not powerful enough, or compounds decompose when vaporizing in the GC inlet for the GC-MS.

Randy Kopper's research focuses on peanut proteins that cause a hypersensitivity response in peanut-allergic individuals. One characteristic of most food allergens is their resistance to enzymatic digestion. If the allergenic epitopes (short strings of amino acids) in these allergens are not hydrolyzed during digestion, they will continue to interact with the intestinal mucosal immune system and initiate an allergic reaction. Randy's research has shown that the conformation of the two major allergenic proteins in the peanut are largely responsible for their resistance to enzymatic digestion. The factors that affect the conformational structure of these proteins might be studied using RP-HPLC since oligomer formation, protein folding and denaturation can now be assessed by HPLC. A recent grant proposal to the Food Allergy and Anaphylaxis Network mentioned the availability of this instrument for the proposed research.

C. Combustion Studies Research

1. Physical Properties of Hybrid Rockets

Ann Wright's research is in the area of measurement techniques and sensors. The current application is in the measurement of pressure and thrust oscillations in hybrid rockets. This work is primarily funded by a NASA EPSCoR grant.

Progress over the last year includes many upgrades to the University of Arkansas at Little Rock (UALR) hybrid rocket research facility and the preliminary testing of a six degree-of-freedom thrust sensor. The facility upgrades include a new control computer and control software, new data acquisition capabilities, and the installation of a mass flow controller on the oxygen line. These upgrades will enhance the ability to do research at this facility by all collaborators. The mass flow controller is especially important to the Hendrix collaborators, Ann Wright and Warfield Teague.

The six degree of freedom thrust sensor has been built and preliminary data has been collected for the primary axis of the rocket. This sensor is composed of a frame that supports the cylindrical rocket body with six aluminum legs. When completed, the legs will have bonded strain gauge circuits to measure force. The force measurements will determine the thrust and torque in the three spatial dimensions.

The thrust sensor design was completed in the summer of 2004 by research students Doug Woten and Tripp McGehee. The research results were presented at the American Physical Society (APS) meeting in the spring of 2005. The design was fabricated during the spring of 2005. Tripp McGehee worked in the summer of 2005 to modify the thrust sensor design and design the conditioning circuit needed to get a signal from the detector legs.

At the completion of summer 2005, the sensor stand was installed on the rocket. Once the stand was determined to be safe, an active leg was placed in the axial position, aligned with the rocket body. Data was collected for three rocket firings. Unfortunately, the sensor experienced too much electromagnetic interference (EMI) from the rocket ignition system. Future work on this project includes shielding the sensor legs and conditioning circuit from the EMI, modifying the size and shape of the active leg to gain more sensitivity in the low thrust range of the rocket, and building and testing the remaining active legs for the sensor.

The machine shop equipment that was requested in this proposal will be purchased in January 2006. The room where the equipment will be housed is being prepared. The addition of the milling machine and lathe will greatly enhance the ability of Dr. Wright and her students to work on this research project at Hendrix. All previous machining was done at UALR. The machine shop will also be available to other physics and chemistry faculty.

2. Other Hybrid Rocket Research

Dr. M. Warfield Teague and his students are using ultraviolet absorption techniques to study the temperature of and reactive species in flames. For the past few years they have collaborated with the Hybrid Rocket Laboratory at the University of Arkansas at Little Rock. The goal of the research is to develop a non-intrusive probe to rapidly monitor burning efficiency and control oxidizer flow into a flame system. Earlier studies investigated OH radical concentration and temperature in the hybrid rocket motor plume as a function of distance from the nozzle and oxidizer flow rates. Changes in temperature due to addition of energetic materials to the fuel have also been measured. Presently, the group is looking at the effect of nozzle ablation (and concomitant) pressure variations on the flame chemistry and the change in OH concentration as a function of oxidizer flow rate.

During the past 9 years, 11 students, with NASA support, have worked on the project: Tonya Felix ('96), Jennifer Welborn ('96), Kari Maxwell (98), Daryl Breithaupt ('98), Dilek Balkanli ('99), Leah Hybl ('00 and '01), Angela Disch ('01), Thomas Jennings ('02), Ian McQueen ('03), Charles Zehm (04-'05), and Renee Riem ('05).

III. Recruitment Initiative

The recruitment component of the HARPS program is geared towards increasing participation in the physical sciences by high school students and introductory college students (first and second year undergraduates). At present, the physical science faculty is working in conjunction with the Office of Admission to design, manage and execute these new programs; though, we anticipate that in time, these new programs will be managed exclusively from the Office of Admission.

We have two programs targeting the recruitment of high school students, research demonstrations for large visitation days and research participation experiences for selected students. Beyond the research component, recruitment of high school students into the physical sciences has been strengthened with new scholarship funds designed to attract students with an identified interest in research. This is part of a larger institutional initiative for experiential learning known as the *Your Hendrix Odyssey* program. For enrolled students, this new Odyssey program offers research grants for summer undergraduate research experiences. Finally, we are working on creating a Chemical Physics Major. A draft of the major has been developed and discussions are ongoing between the Chemistry and Physics departments on the details. Beyond the specific programs mentioned herein, we are also working to identify the type of data necessary to help us distinguish the students that will persist in the physical sciences and to assess this project in the long term.

Recruitment of high school students We have formalized our participation in the large visitation days by providing research demonstrations, primarily staffed by our undergraduate researchers. Demonstrations give us a chance to interact informally with a large number of prospective science students. While this has occurred sporadically in the past, demonstrations will now be a formal agenda item giving us greater exposure to prospective science students.

At present, students sign up for small group (5-10) research demonstration experiences at the beginning of the visitation day, giving the faculty estimates as to the numbers participating later in the afternoon. If the numbers of participants are small (less than five), a hands-on format will be tried rather than a demonstration model approach.

This last year we ran two of these: November 3, 2004 – recruiting from Arkansas School for Math, Science and the Arts (ASMSA) and November 19, 2004 – Pre-Medical sciences day. We saw eight students the first date and 15 on the premed day. From the ASMSA day, 23 % of the students enrolled this fall, although not all participated in our outreach experience. Of all the students that visited on the pre-med day, 32% enrolled, of those that participated in the demonstrations ~ 50 % enrolled. We believe that these experiences will influence students beyond those that actually attended the sessions through "word-of-mouth." This is particularly true for closely knit groups that visit, such as the students from the residential ASMSA.

An effective model for the research participation experiences was designed last year and will be implemented this academic year. All the chemistry and physics faculty will provide one hands-on opportunity for a pair of students in the spring, with their high school teacher if possible. The College will already have accepted these students for the following fall enrollment, and most students will have been offered some level of scholarship funds. These should be high yield students. Admission will manage this opportunity and distribute the students among the available faculty research slots.

The research participation program will also be used by the Office of Admission to educate high school science teachers about Hendrix College in order to create a pipeline for bringing talented students to Hendrix. A target city initiative within Admission will be used to identify and then recruit high school science teachers to come visit Hendrix. It is expected that these science teachers will help identify talented science students and direct their highly interested students towards the physical sciences at Hendrix.

Scholarship Support - This year is the first year of the College's Odyssey initiative for experiential learning. Scholarship funding is available for incoming students interested in research as part of this program. A total of 47 research awards were offered in disciplines across the campus and 21 enrolled this fall. Of those 21 Odyssey research awards accepted by enrolling students, 14 students gave science as their major of primary interest. We will track these students to identify their final majors.

Recruitment of introductory undergraduate science students As part of the Odyssey initiative on campus, research funds for undergraduate summer work have been made available. At present, four of these mini grants have been awarded to faculty in the physical sciences to support summer research with undergraduates -two to Liz Gron (Jeffery Herrold, 2004, and Sarah Tauer, 2005) and two to Bob Dunn (Julie Coates, 2004 and Neil Kopper, 2005).

IV. Summary

This Research Corporation Special Grant investment in the Departments of Chemistry and Physics at Hendrix is helping us increase interest and participation of students in the physical sciences, both during and after their time at Hendrix College. Although it will be several years before we have the recruitment numbers to indicate success, this grant has given us the opportunity to develop new and important recruitment initiatives at Hendrix, which will help us secure the future of physical science research here.

Financial Report August 2005 for the Research Corporation Special Grant

Research Equipment ($164,750)				
Dionex Summit HPLC system	$	42,185		
ArF Excimer Laser and gases	$	33,832		
total	$	76,017	$	76,017
Recruitment ($35,250)				
Odyssey Science Scholarships	$	43,000		
Odyssey Research Grants	$	18,000		
total	$	61,000*	$	35,250
Total Expenditures for Grant			$	111,267

* This amount is above the maximum planned for in the grant so only $35,250 was charged to the project total of $200,000.

Course Syllabus for Organic Chemistry I, CHEM 240, Fall Semester, 2005

Thomas E. Goodwin
Elbert L. Fausett Professor of Chemistry
Office: Acxiom Hall 213
Phone: 450-1252; **e-mail:** goodwin@hendrix.edu

• **GENERAL INFO:** Class meets in Mills A, Period A-4 (11:10-12:00), MWF. I expect you to attend every day, although I recognize that occasional absences are unavoidable. Lab is scheduled for Period L-6 (1:10-4 pm, M) or Period L-8 (1:10-4 pm, W), in Acxiom Hall, rooms 209 and 210. On some lab days, we will meet first in Acxiom 119 for a short pre-lab lecture, or for a longer lecture/discussion that will substitute for an experiment. If you are pregnant, or become pregnant during this course, it is IMPERATIVE that you let me know so we can discuss arrangements for the laboratory.

• **REQUIRED TEXTS:**

I. **Organic Chemistry**
John McMurry
6th Edition, Brooks/Cole, 2004
(Take a look at the Appendices; some of them may be useful.)

II. **Organic Chemistry, Study Guide and Solutions Manual**
Susan McMurry
6th Edition, Brooks/Cole, 2004
(Take a look at the Appendices; some of them may be useful. Be sure to check out the website **"Organic Chemistry Direct"**: http://chemistry.brookscole.com/mcmurry6e.)

III. There is no lab textbook to buy, but you will need a lab notebook. We are using a new type of lab notebook (**NOT** the same one as the general chemistry labs). It is called "Organic Chemistry Laboratory Notebook" by Thompson Publishers, and is in the Hendrix bookstore. You will also need protective gloves, which will be available at the chemistry stockroom in Acxiom Hall. You must have proper safety glasses. These can be purchased at the stockroom window.

• **HAND-HELD MOLECULAR MODELS** (Optional): Chem-Tutor Student Modeling System for Organic Chemistry, available for approx. $13 from stockroom during laboratory period. In many chapters (e.g. 4 and 9), you may find these to be especially useful for visualization of molecules in three dimensions.

• **EVALUATION**: Major Exams count 60 or 65% of the total grade. (These will always be announced at least three days in advance.) The Final Exam is mandatory, multiple choice, and counts 15 or 20% of the total grade. [NOTE: I will figure your grade using the combination of percentages (60 + 20, or 65 + 15) that gives you the highest overall percentage.] Exams must be taken on the scheduled date unless officially excused by Dr. Goodwin for such things as varsity sports events, illness, family emergency, etc. Having another exam on the same or nearby day is not ordinarily a sufficient reason to reschedule your test in this class. If you have some disability that might cause you to need extra time on an exam, you should tell me now, before ever starting to take an exam (please see the statement in the next paragraph*). **THE FINAL EXAM IS ON TUESDAY, DECEMBER 13, FROM 8:30-11:30 AM (see the Hendrix catalog). YOU ARE EXPECTED TO BE THERE.** (Tell Mom and Dad not to buy you any plane tickets or book any cruises until AFTER that date.) Laboratory counts 20% of the total grade. In order to pass the course, it is necessary to attend all the lab sessions and turn in all the lab write-ups, unless specifically excused by Dr. Goodwin. Lab write-ups turned in long after the due date without permission of Dr. Goodwin will be subject to point deductions.

*It is the policy of Hendrix College to accommodate students with disabilities, pursuant to federal and state law. Any student with a disability who needs accommodation, for example in arrangements for seating, examinations, note taking, or access to information on the web, should inform the instructor at the beginning of the course. In order to receive accommodations, students with disabilities are required to contact Counseling Services at 450-1448.

• **MAJOR TOPICS COVERED**: We will probably cover Chapters 1-11, the infrared portion of Chapter 12, and Chapter 15 of McMurry's book during the Fall Semester. **Unless specified otherwise in class, all problems within a chapter and at the end of a chapter are always assigned.** Since I do not collect solved problems, however, working problems is at your discretion. I believe this is one of the best ways to learn organic chemistry. I'll always include some problems on each test that have been taken directly from the text. It may be necessary and desirable to use our lab periods on occasion for supplemental lectures; these will be announced in advance. It is very important that you do not get behind on your studies. A great deal of study time will be required outside of class. You must play a major, active role in your own education by reading the assigned material, working the assigned problems, and asking questions when confused. I want to help.

• **GREEN CHEMISTRY**: For many years we have been reducing risk and environmental impact by using smaller quantities of chemicals in lab (microscale organic chemistry). We are also focusing on more environmentally benign ("green") experiments. I believe that we are at the forefront of this developing international trend in education. We will be discussing green chemistry lab philosophies and techniques frequently throughout the year.

• **GRADING SCALE**: Usually I do not deviate from the following scale:
100-85 = A; 84-75 = B; 74-60 = C; 59-50 = D; 49-0 = F. **I do reserve the option, however, for small deviations from the scale if, based upon my experience and the particular circumstances, I believe that this is justified.**

• **HELP SESSIONS**: I will schedule extra problem-solving sessions (usually four per week) in Acxiom Hall or MCReynolds Hall outside of normal class time. The precise times and location of these help sessions will be announced in class soon. Attendance is optional.

• **APPOINTMENTS:** If you need to meet with me outside of class, PLEASE MAKE AN APPOINTMENT. I promise that we will work out a mutually convenient time to meet as soon as possible. I have voicemail, so you can call anytime and leave a message, or send me an e-mail; I will get back in touch promptly. Of course, you may drop by my office with no appointment, but I may be busy and not be able to help you at that time.

• Please read about the College's Academic Integrity policy (please scroll to pages 6-10 of http://www.hendrix.edu/catalog/04-05Catalog/Policies&Regulations.pdf). You will be expected to abide by this policy.

ONCE YOU HAVE READ AND UNDERSTAND THIS SYLLABUS, PLEASE SIGN THE AFFIRMATION AT THE BOTTOM OF THE PERSONAL DATA SHEET AND TURN IT IN

TO ME. **Thanks for taking this class. You'll learn a lot if you work hard, and we'll try to have some fun along the way too.**

Appendix A
Publications in the Chemistry and Physics Departments from 1994-2005

R. Rolleigh, M. Bell, M. Rolleigh, and D. Bandy, "Effects of Finite Apertures on Transverse Eigenmodes of Optical Resonators," J. Opt. Soc. Am. A., **16**, 2669, (1999).

T. Sarkisyan, A. Oraevsky, A. Rosenberger, R. Rolleigh, and D. Bandy, "Nonlinear Gain and Carrier Temperature Dynamics in Semiconductor Laser Media," J. Opt. Soc. Am. B, **15**, 1107, (1998).

Bandyopadhyay, Pradip K., Rolleigh, R., Gray, J., Arnold, R., Swindle, R., and Zimmerman, A., "Spatial Distribution and Thermal Diffusion of Indocyanine Green in Solid Tumors in Laser-Assisted Cancer Immunotherapy", Journal of Biomedical Optics, 2005 (manuscript in preparation.)

Bandyopadhyay, Pradip K. , Holmes, Kyland, Burnett Corrinthius, and Zharov, Vladimir, P., "Temperature Control in lasr Assisted Cancer Immunotherapy", Proc. SPIE, Laser-Tissue Interaction XIV, vol. 4961, (2003)

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Chakrabarti K., Bandyopadhyay P. K. and Barkyomb J. H., "Copper Doped Alkali Halides for Computed Radiography and Digital Imaging", Journal of Digital Imaging, 11 , No 3, 174 (1998).

R. B. Hurst, R. W. Dunn, K. U. Schreiber, "Mode behaviour in ultra-large ring lasers," (Submitted Appl. Opt., August 2003).

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A. M. Wright et al , "A Thrust and Impulse Study of Guanidinium Azo-Tetrazolate as a Fuel Additive for Hybrid Rocket Motor", submitted to Journal of Pyrotechnics 6/05 and under review.

A.B. Wright, A.M.Wright, et al , "Optical Studies of Combustion Chamber Flame in a Hybrid Rocket Motor", Journal of Pyrotechnics, Issue 19, Summer 2004.

M.K. Hudson, A.M. Wright, M. W. Teague, "Guanidinium Azo-Tetrazolate as a High Performance Hybrid Rocket Fuel Additive", Journal of Pyrotechnics, Issue 19, Summer 2004.

A.M. Wright and G. Ferrer, "A Liberal Arts Approach to Teaching Robotics", American Society of Engineering Education (ASEE) Annual Conference Proceedings, 2003-1236.

A. B. Wright and A. M. Wright, "FIRST in Engineering: Elements of Mechanical Design", ASEE Annual Conference Proceedings, 2003-1604.

A. Chouinard, A. Adams, A.M. Wright, M.K. Hudson, "Multi-wavelength Laser Opacity Study of a Hybrid Rocket Plume", Issue 15, summer 2002, Journal of Pyrotechnics.

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A.M. Wright et al., "A Study of the Amplitude of Pressure and Thrust Oscillations in a Lab-Scale Hybrid Rocket", Arkansas Academy of Sciences Journal, vol. 54.

A.M. Wright et al., "A Thrust and Impulse Study of Guanidinium Azo-Tetrazolate as an Additive for Hybrid Rocket Fuel", AIAA-99-2538.

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A.M. Wright et al, "A Hybrid Rocket Regression Rate Study of Guanidinium Azo-Tetrazolate", AIAA-98-3186.

A.M. Wright et al, "A Hybrid Rocket Regression Rate Study of AminoGuanidinium Azo-Tetrazolate", AIAA-98-3187.

Effect of Energetic Fuel Additives on the Temperature of Hybrid Rocket, M. W. Teague et al., AIAA-99-2138.

"Charged Particle Detection in Rocket Plumes for Health Monitoring", R. Dunn et al, International Journal of Turbo and Jet Engines. Vol 16,255-262, 1999.

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"Crystal Structure of (4α,4aα,8aα)-(±)-Octahydro-2-(phenylmethyl)--2*H*-1,2-benzoxazin-4-ol, 4-Methylbenzenesulfonate (ester)," W. Cordes, J. L. Smith, M. C. Noble, T. E. Goodwin, D. M. Cousins, and E. G. Jacobs, *J. Chem. Cryst.* **1998**, *28*, 133.

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"ATEC- Project Based Junior laboratory at Hendrix College," L. Gron, D. A. Hales, and M. W. Teague, *J. Chem. Ed., manuscript in preparation.*

"Production of Boron Bromide Cage Cluster Positive Ions from Boron Tribromide in a Pulsed Discharge Ion Source", David A. Hales and Jay S. VanDenbos, Submitted to *Int. J. Mass Spec.*, 14 June 2002; requested revisions could not be completed in the allowed time. Presently under revision for submission to *J. Phys. Chem. A.* with additional student coauthors: Tony P. Tauer, R. Bret Yarbro, Shawna M. Rigsby, and Thea P. Price.

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Appendix B
Grants and Pending Proposals, since 1994

NIH Grant, Idea network for Biomedical Research Excellence (INBRE) Award, "Investigation of Thermal Effects in Photodynamic Therapy to Treat Solid Tumors", $658,650, 2005-10

NIH-AREA GRANT, Optical Dosimetry in Laser-Assisted Cancer Immunotherapy, Natioanl Institutes of Health, $155,000, July 2003 – June 2005

AR BRIN Summer Faculty Fellow, NIH, Dose Measurements in Cancer Therapy, UAMS, $15,000 (approx.) July-August, 2002

AR BRIN Equipment Grant, NIH, $28,000 (approx.), Cancer Therapy project, 2002-03

Navy-ASEE Summer Faculty Research Fellow, Thermoluminescence Dosimetry, Naval Surface Warfare Center, Washington, D.C., $15,000 (approx.) June-August, 2000

SURF SILO Grant, Faculty mentor (Student: Kyland Holmes), Sensitivity of LiF Dosimeter, $3,200 (approx.), 2002

Principal Investigator, Arkansas Space Grant Consortium, NASA. Research on Phosphor Development, $3000 (approx.), December 1998 to February 2000.

Visiting Scientist, India. Performed research with the Health & Safety Division, IGCAR, on Photo-Stimulated Luminescence of Copper & Europium Doped Alkali Halide Phosphors, 1997-98.

Principal Investigator, Arkansas Science & Technology Authority Grant. Research involving Studies of Alkali Halide Phosphors as Imaging Plates in Digital Radiography, $60,000 (approx.), 1995-97.

NSF MRI/RUI Development of a Large Ring Laser For Earth Science Measurements, $256,602.00

NASA EPSCoR (This is part of a collaborative grant with the University of Arkansas at Little Rock.) (2000 – 2003), $10,500.00

NSF International Large ring Lasers for Geophysical Measurements (4 Feb 2002-4 Feb 2005), $39,650.00

Marsden (This is the New Zealand equivalent of NSF. It helps support ring laser effort in New Zealand.) (2002 – 2004), $30,000.00 NZ, about $12,600.00 US

Research Corporation (2001) (Provided support for Sarah Bates to go to New Zealand on the ring laser project), $6,000.00

NASA Arkansas Space Grant Consortium (Sep 15, 00), Two Undergraduate Fellowships, $5,410.00

Research Corporation Travel Grant (Jul 1, 00), $2,350.00

NASA Arkansas Space Grant Consortium (Mar 1, 00), Hybrid Rocket Exhaust Combustion Study, $4,000.00

NASA – Stennis Space Center (Jul 21, 98), Noninvasive Detection of Metallic Ions in a Hybrid Rocket Plume, $20,000.00

Arkansas Science and Technology Authority, ASTA (February 4, 1997), Platform Stabilization Using Large Ring Lasers, $28,753.00

NASA – Stennis Space Center (Sep 5, 96), Detection of Metallic Compounds in Rocket Plumes Using Ion Probes, $15,000.00

SILO/SURF (1994-1996), 3 Undergraduate Fellowships, $10,800.00

Arkansas Space Grant Consortium (1994 – 1998), 6 Undergraduate Students, $39,637.00

"Optical Dosimetry in Laser-Assisted Cancer Immunotherapy", National Institute of Health, 1R15CA090868-01, $155,000.00, Co-PI, July 2003 - July 2005

"Carrier States in Semiconductor Quantum Dots," SURF/SILO, $3900.00, November 2000.

"Transverse Effects in Semiconductor Lasers," Research Corporation Cottrell College Grant: CC4375, 1997-1999.

Modeling Semiconductor Lasers with Circular Apertures, SURF/SILO, $3,900.00, November 1999.

"Finite Aperture Effects in Semiconductor Lasers," SURF-SILO undergraduate research grant (1998).

"Coupling of Transverse & Dynamic Carrier Temperature Effects in Semiconductor Lasers." SURF-SILO undergraduate research grant (1997).

"Theoretical Modeling of Semi-Conductor Lasers," Arkansas Space Grant Consortium: HU12. (1996).

Departmental Development Grant to strengthen the Chemistry and Physics Departments (co-PI) from Research Corporation of Tucson. Award Number DD0002, 1993.

"Collaborative Arkansas Research Partnerships," (co-PI) Research Corporation Grant GG-019, 1992.

NASA EPSCoR Grant. $287.5K per year for 5 years. Title: "Instrumentation for Diagnosis of Chemical Rocket Motors", 2002-2007.

Arkansas Space Grant Consortium, $2500 from ASGC to pay for travel and expenses for Ryan Swindle to attend a summer robotics program at NASA Goddard. 2005.

Arkansas Space Grant Consortium for $3000 student salary, 2001.

NASA Grant for FIRST Robotics Team #356, $7,000 for 2001.

NASA Grant for FIRST Robotics Team #356, $6,000 for 2000.

NASA EPSCoR Grant: $10,000 summer salary. 1999.

Arkansas Space Grant Consortium: $3,800 awarded February, 1999.

Arkansas Space Grant Consortium: $3140 awarded January 1999.

Arkansas Space Grant Consortium: $3000 awarded January 1999.

M. Warfield Teague and Ann Wright, Co-Investigators, "Instrumentation for Diagnosis of Chemical Rocket Motors," NASA EPSCoR 2000, $287,000/yr for five years (includes collaboration with Harding and UALR).

2002-2007 NASA EPSCoR Grant. $287.5K per year for 5 years. Title: "Instrumentation for Diagnosis of Chemical Rocket Motors"

2005 $2500 from ASGC to pay for travel and expenses for Ryan Swindle to attend a summer robotics program at NASA Goddard.

"Integration of High Field NMR Spectroscopy and Molecular Modeling into the Undergraduate Chemistry Curriculum"; NSF-ILI (Instrumentation Laboratory Improvement); funded in early 1994. The P.I. was Tom Goodwin. Of the total instrument cost 3/6 came from the NSF-ILI grant, 2/6 from the Research Corporation Department Development Award, and 1/6 from another source.

"Synthesis of New Primaquine Analogs for *P. carinii*".A three-year grant for $105,754 from the NIH-AREA (Academic Research Enhancement Award) program (Division of AIDS), award period 8/15/94-8/14/97. The project was entitled

"Identification and Synthesis of Elephant-Derived Natural Products," ACS-PRF-B. $30,000 grant from for the period 6/1/99-8/31/01 for a project entitled

"Collaborative Research: Development and Identity of Sexually Dimorphic Reproductive Signals and Responses by African Elephants"; NSF Collaborative Research at Undergraduate

Institutions Program, from the Animal Behavior Program of the Division of Integrative Biology and Neuroscience; start date 9/1/02; duration 48 months; total grant $842, 251; Co-PIs:

- Bruce A. Schulte, Department of Biology, Georgia Southern University;
- L. E. L. (Bets) Rasmussen, Department of Biochemistry and Molecular Biology, Oregon Health and Sciences University
- Thomas E. Goodwin, Department of Chemistry, Hendrix College

Research Corporation, Department Development Grant, summer research grant "Structure of Messenger RNA Within Intact Cell Nuclei" funded at $10,000 for one year, 1994.

Arkansas Science Information Liaison Office Undergraduate Research Fellowship program "Structure of Messenger RNA in Polysomes" funded at $3630 for one year, 1995.

Research Corporation, Department Development Grant, summer research grant "Messenger RNA Structure Within Polysomes" funded at $10,000 for one year, 1995.

Hendrix College faculty project grant (institutional), summer research project in biochemistry, funded at $800 for one year, 1995.

Camille and Henry Dreyfus Special Grant Program in the Chemical Sciences, "Development of a Biochemistry Laboratory Using Physiologically Relevant Samples" funded at $12,000 in 1996.

National Science Foundation, Instrumentation and Laboratory Improvement (NSF-ILI), "Development of a Biochemistry Laboratory Using Physiologically Relevant Samples" funded at $22,721 in 1996.

Hendrix College faculty project grant (institutional), summer research during sabbatical, funded at $1,650 for one year, 1997.

National Science Foundation, Chemistry Research Instrumentation and Facilities (CRIF), "Purchase of GC/MS Instrumentation for Identification of Organics from High Temperature Water Reactions" funded at $72,524 for three years, 1997.
Hendrix College faculty project grant (institutional), summer research during sabbatical, funded at $1,000 for one year, 1998.

Research Corporation Cottrell College Science Grant "Biochemical Characterization and Effect of Digestion on the Allergenic Properties of a Major Peanut Protein" funded at $40,138 for three years, 2001-2003.

“Boron Halide Cluster Ion Formation and Structure: Experiment and Theory”, National Science Foundation (NSF-RUI) CHE-0212586, 15 August 2002 - 14 August 2005, $136,700.

"Ion-molecule reactions in gas-phase clusters and buffer gas flows", National Science Foundation (NSF-RUI) CHE-9505444, 1 July 1995 - 30 June 1998, $88,989.

"Cation-radical polymerization of molecules in gas-phase clusters and buffer gas flows", Research Corporation CC-3484 (renewal), 1 May 1995 - 30 April 1996, $10,000.

"Laser-Based Spectroscopy and Kinetics Apparatus for a New Junior-Level Unified Laboratory: 'Advanced Techniques in Experimental Chemistry'", National Science Foundation (NSF-ILI-IP) DUE-9750550, 1 June 1997 - 31 May 1999, $21,975. PI: D. A. Hales. Co-PIs: M. W. Teague, L. U. Gron.

"Laser-Based Spectroscopy and Kinetics Apparatus for a New Junior-Level Unified Laboratory: *Advanced Techniques in Experimental Chemistry*", The Camille and Henry Dreyfus Foundation SG-97-039, 21 January 1997, $22,483. PI: D. A. Hales. Co-PIs: M. W. Teague, L. U. Gron.

"FTIR for Development and Implementation of an Upper-Level Integrated Laboratory at Hendrix College", The Camille and Henry Dreyfus Foundation, January 1995, $17,500. PI: M. W. Teague. Co-PIs: D. A. Hales, L. U. Gron.

"Integration of High Field NMR Spectroscopy and Molecular Modeling into the Undergraduate Chemistry Curriculum", National Science Foundation (NSF-ILI-IP) DUE-9451256, 1 June 1994 - 31 December 1996, $83,613. PI: T. E. Goodwin. Co-PIs: D. A. Hales, R. A. Kopper, M. W. Teague.

Teaching Materials Science in the General Chemistry Curriculum, NSF-subgrant, awarded December 1994, $3,400.

Development of Palladium-Mediated Reactions of Organic Molecules in Near-critical Water, Research Corporation Cottrell College Science Award, awarded May 1994, $33,950.

Supercritical and Near-critical Water: Exotic Media for Facilitating the Interaction of Transition Metals and Organic Substrates, ACS-Petroleum Research Fund, awarded May 1994, $20,000.

Wacker-type Selective Oxidation Chemistry in High Temperature Water, SILO Advisory Council - Undergraduate Research Fellowship (SURF), awarded November 1, 1996, $3,483.66.

Synthesis in High Temperature Water, Council on Undergraduate Research Undergraduate Student Summer Research Fellowship in Science, CUR, awarded May 1998, $3,000.

Tailoring Palladium-Catalyzed Reactions for Use in High Temperature Water, Research Corporation Cottrell College Science Award, awarded May 1999, $37,000.

ACS Environmental Program for a Campus Environmental Awareness Mini-grant to bring Terry Collins to campus to speak on sustainability in science and environmental ethics, awarded January, 2003, $1000.

Filling the Void: Educating Environmentally Responsible Citizens and Scientists Through Green, Environmental Chemistry, The Camille and Henry Dreyfus Foundation Special Grant Program in the Chemical Sciences, project total $17,000, awarded January 2004.

Green Chemistry: Diels-Alder Reactions in High Temperature Water, Galileo Award Hendrix College,$6000, March 2004.

Green Chemistry: Diels-Alder Reactions in High Temperature Water, The Petroleum Research Fund of the American Chemical Society $50, 000 (project total $60,800) awarded May 2004.

Green Chemistry: Diels-Alder Reactions in High Temperature Water, Hendrix College Odyssey Award, $2,400, March 2005.

"Development of an NSF interdisciplinary undergraduate research center" submitted to NSF in collaboration with UALR. Five years at $136,000.

"Reduction of Peanut Allergenicity by Adsorption on Activated Charcoal" submitted to Food Allergy and Anaphylaxis Network. Two years at $40,000.

Appendix C

Student Presentations in the Chemistry and Physics Departments from 2000-2005

Faculty mentor	Student	Title of presentation
APS National Meeting March 2000- Minneapolis, MN		
Dr. Bandyopadhyay	John Redford	Photo-Stimulated Luminescence in KBr:Cu: It's Correlation with the Irradiation Temperature
Dr. Dunn	Hunter Mack	Noninvasive Detection of Metallic Ions in a Hybrid Rocket Plume
Dr. Rolleigh	Eric Mortenson	A Semiconductor Laser Model Including Dynamic Carrier Temperature
	Matt Reason	A Semiconductor Laser Model Including Finite Aperture Effects
Dr. Wright	Justin Patton	Tetrazolate as an Additive for Hybrid Rocket Fuel
NCUR – April 2000 – U. of Montana		
Dr. Bandyopadhyay	John Redford	Photo-Stimulated Luminescence in KBr:Cu: Thermal Properties
Dr. Dunn	Chelsey Bryant	Stabilization of Large Ring Laser Interferometers
Dr. Rolleigh	Eric Mortenson	Semiconductor Laser stability and dynamic temperature
	Matt Reason	Finite Aperture Effects on semiconductor stability
Dr. Wright	Justin Patton	Tetrazolate as an Additive for Hybrid Rocket Fuel
APS National Meeting March 2001- Washington, DC		
Dr. Bandyopadhyay	John Redford	Photo-Stimulated Luminescence of Copper Doped Single Crystal of KBr X-irradiated at 77 K
	Cody Hopkins	The Role of Copper Impurity in the Photo-Stimulated Luminescence from KBr Single Crystals X-irradiated at 77 K
Dr. Wright	Dagim Tilahun	Effects of High Concentration Guanidinium Azo-Tetrazolate on Thrust and Specific Impulse of a Hybrid Rocket

Faculty mentor	Student	Title of presentation
NCUR – April 2001 – Lexington, KY		
Dr. Bandyopadhyay	Kyland Holmes	Low Temperature Thermoluminescence of LiF:Cu, Mg, P Dosimeter
	Cody Hopkins	Photo-Stimulated Luminescence of Copper Doped Single Crystal of KBr X-irradiated at 77 K
Dr. Dunn	Sara Bates	Non-Linear Thermal Effects in Microsphere Whipering-Gallery Modes
Dr. Rolleigh	Larry Dunn	Detection of Amyloin Fibril formation in hen egg white Lysozyme using dynamic light scattering.
	Brian Alford	The recovery of the old nova CAR (1895)
Dr. Wright	Patrick Foley	Effects of High Concentration Guanidinium Azo-tetrazolate on Thrust and Specific Impulse of a Hybrid Rocket
APS National Meeting March 2002- Indianapolis, MN		
Dr. Bandyopadhyay	Kyland Holmes	Low temperature thermoluminescence in LiF: Mg, Cu, P Dosimeter
	James Smith	Photo-Stimulated Luminescence in KCI:Cu X-Irradiated at 77K
Dr. Rolleigh	Laura Walizer	A Monte-Carlo Model of Light Interaction With Tissue
	Brian Alford	A Theoretical Model of Pyramidal InAs/inP Quantum Dots
	Lawrence Dunn	An Analysis of the Performance of a Reflective Square Pyramidal Optical Mixer and Concentrator.
NCUR – April 2002 – Madison, WI		
Dr. Bandyopadhyay	Kyland Holmes	Low Temperature Thermoluminescence of LiF:Cu, Mg, P Dosimeter
	Cody Hopkins	Photo-Stimulated Luminescence of Copper Doped Single Crystal of KBr X-irradiated at 77 K
	James Smith	Origin of Photo-Stimulated Luminescence in KCI:Cu X-Irradiated at 77K
Dr. Dunn	Sara Bates	Seismic Wave Analysis Using Large Active Ring Laser Interferometers

(continued)

Faculty mentor	Student	Title of presentation
Dr. Rolleigh	Larry Dunn	An Analysis of a Reflective Square Pyramidal Optical Mixer and Concentrator.
	Brian Alford	The recovery of the old nova CAR (1895)
	Carter Price	Modeling Heat Transfer in Living Tissue
Dr. Wright	Patrick Foley	Two stage pressure analysis of a hybrid rocket
	Dagim Tilahun	6-Channel Ellipsometery
	Greg Webb	Dual Pressure Measurements of a Hybrid Rocket
NCUR – April 2003 – Salt Lake City, UT		
Dr. Bandyopadhyay	Kyland Holmes	Optical dosimetry in laser-assisted cancer therapy
Dr. Dunn	Sara Bates	Seismic Wave Analysis Using Large Active Ring Laser Interferometers
Dr. Rolleigh	Laura Walizer	Monte Carlo Simulations of Light Interacting with Heterogeneous Tissue
Dr. Wright	Dane Dormio	Evaluation of Several Original and Commonly Used Solar Cooker Designs
NCUR – April 2004 – Indianapolis, IN		
Dr. Bandyopadhyay	Adam Zimmerman	Laser Assisted Cancer Immunotherapy: ICG Distribution in Tissue
	John Gray	Laser Assisted Cancer Immunotherapy: Measurement of Tumor Temperature
Dr. Rolleigh	Ivan Bogdanovic	Dynamic Damage model of optical and thermal properties of tissue.
American Physical Society Meeting, March 2005. Los Angeles CA.		
Dr. Bandyopadhyay	Robert Arnold	Temperature Control During the Delivery of Laser Assisted Cancer Immunotherapy
	Ryan Swindle	Laser Assisted Cancer Immunotherapy: Optical Dye Distribution in Tumors
	John Gray	Laser Assisted Cancer Immunotherapy: An Experimental Theraputic Approach in Balb/c Mice
Dr. Dunn	Julie Coats	Large Ring Laser Gyroscopes for Geo\-physical Measurements
Dr. Rolleigh	Gregory Varner	The Effect of Heterogeneous Conductivity on Thermal Diffusion in Tissue
Dr. Wright	Tripp McGehee and Doug Woten	Design of a Six Degree of Freedom Thrust Sensor for a Hybrid Rocket
	Tripp McGehee and Doug Woten	Design of Force Sensor Leg for a Rocket Thrust Detector for a Hybrid Rocket

(continued)

Faculty mentor	Student	Title of presentation
ACS National Meeting - April 2000 – San Francisco, CA		
Dr. Goodwin	Russell Roberson	Selectivity Studies in the Methyltrioxorhenium-Catalyzed Epoxidation of (E,E)- Farnesol with H_2O_2, Synthesis of Elephant-Derived Sesquiterpenes.
	Felisia Brown	A Simple Technique for Manual, Solid-phase Synthesis of Peptoids by the Sub-monomer Method
Dr. Kopper	L. E. Brumley:	Metal Ion Cofactor Specificity of Alkaline Phosphatase
	Nathan Schlientz	Enzyme Kinetics Under Partially Denaturing Conditions
Dr. Hales	Michael W. Chaney	Comparative Computational Studies of Boron Halide Cluster Ions
Dr. Gron	Matthew T. Rawls	Additive-free activation of aryl bromides for Heck reactions in High Temperature Water
	Suzanne E. Jensen	Heck reactions in High Temperature Water: Evaluation of Rigorous Conditions
	Ian D. Miller	Compatibility of Heteroatom Reactants for Heck Reactions in High Temperature Water
	Cortney J. Higgins	Pressure and Water Density: New Variables for Heck reactions in Superheated Water
ACS National Meeting - April 2001 - San Diego, CA		
Dr. Goodwin	W. Richard Counts	Sesquiterpenes in African elephant temporal gland secretions
	Randy A. Hughes	Synthesis, characterization, and bioassay of novel elephant-derived sesquiterpenes
	Daniel Mwanza	SPME and GC-MS to identify organic compounds in African elephant urine
	Dominika M. Szwedo	Intramolecular Heck reactions of bromopyrroles
Dr. Kopper	Claire M. Carle	Alkaline phosphatase activity under partially denaturing conditions
	Jeffrey W. Munos	Activity and specificity of various aryldiazonium salts as chemical nucleases
	Lily Zhou	Characterization of allergenic proteins isolated from a single peanut
Dr. Hales	Beth Kautzman	Ion-molecule chemistry of boron tribromide cluster ion growth
	Nathan Williams	Halogen Dependence of Chemistry in Ionized $(BX_3)_n$ Clusters
Dr. Teague	Angela Disch	Hybrid rocket motor efficiency measured by OH absorption spectroscopy

(continued)

Faculty mentor	Student	Title of presentation
Dr. Gron	Stacey Martin	Water density effect on Diels-Alder and Heck reactions in high temperature water
Outside sponsors	Colin Blair	Photochemistry chemistry of oligomeric analogues to conducting polymers
	Courtney Higgins	Classical trajectory study: pyrazine and carbon monoxide

ACS National Meeting - March 2002 - Orlando, FL

Dr. Goodwin	Nichole Dowdy	Implementation of SPME and GC-MS to Identify Compounds in Elephant Urine
	Daniel Liu	Metal-Catalyzed Cross-Couplings of Bromopyrroles
Dr. Kopper	MeghanWilliams	Effect of Protein Structure on Digestion and Allergenicity of a Peanut Allergen
	Margaret Spivey	Extent of Glycosylation of Allergenic Proteins Isolated from a Single Peanut
	Stacie Moseley	Reactivity and Specificity of Various Aryldiazonium Salts as Chemical Nucleases
Dr. Hales	Jay VanDenbos	Ion-Molecule Chemistry of Boron Bromide Cage Cluster Ion Formation
	Joshua Woolley	Structures and Stabilities of Iodine Cluster Ions
Dr. Teague	Thomas Jennings	UV Spectroscopic Monitoring of Rocket Motor Combustion Efficiency
Dr. Gron	Stacey Martin	Reaction and Kinetics of Diels-Alder Reactions in High Temperature Water
	Stacey Martin	Acceleration of Diels-Alder Reactions in High Temperature Water
Outside sponsors	Tony Tauer	Prediction of Sleep-Inducing Activity of Barbiturates Using Neural Networks

ACS National Meeting - March 2003 - New Orleans, LA

Dr. Goodwin	Ben Davis	Use of SPME & GC-MS for chemical analysis of urine from African elephants in musth
	Whitney Dill	Chemical analysis of preovulatory female African elephant urine: search for pheromones
	Adam Hicks	Development of a green epoxidation experiment for the introductory organic laboratory
Dr. Kopper	Jessica Gallagher	Role of protein secondary and tertiary structure on enzymatic digestion

Faculty mentor	Student	Title of presentation
	Joey Odum	Stability of allergenic peanut proteins toward enzymatic digestion
Dr. Hales	Tony Tauer	Mechanisms of boron bromide cage cluster ion formation: a computational study
Dr. Gron	Ian McQueen	Examination of the enforced-hydrophobic effect in Diels-Alder reactions

ACS National Meeting - March 2004 - Anaheim, CA

Dr. Goodwin	Adam A. Carver	Chemical Analysis of Urine from Male Elephants by SDS-PAGE, SPME & GC-MS
	Grant G. Morshedi	Heterocycles We Have Identified In African Elephant Urine: A Search For Pheromones
	Patrick A. Brown	SPME/GC-MS Methodology For Chemical Analysis Of Female African Elephant Urine
	Dustin C. Freyaldenhoven	Chemical Analysis of Temporal Gland Secretions From African Elephants
	Leighton Satterfield	Study of Female African Elephant Urinary Proteins
Dr. Kopper	Stephen G. Routon	Peanut Protein Allergen Binding to Activated Charcoal
	J. D. Prichard	Characterization of Intermolecular Forces within Protein Trimers
	Rachel Box	Investigation of Protein Tertiary Structure by Proteolysis under Denaturing Conditions
Dr. Hales	R. Bret Yarbro	Dissociation Of Mass-Selected Boron Halide Cluster Ions
	Thea P. Price	The Structures And Thermochemistry Of Boron Bromide Cage Cluster Ions
	Shawna M. Rigsby	Optimization of a Temporal Mass Gate in a Time-Of-Flight Mass Spectrometer
Dr. Gron	Jacy L. Wagnon	The Kinetics of the Cyclopentadiene Dimerization in High Temperature Water
	EllaCathrine E. Whaley	Methyl Vinyl Ketone and Cyclopentadiene Diels-Alder Reaction in High Temperature Water
Dr. Hill	Ian Rummel	Use of Dicyclohexylcarbodiimide (DCC) To Facilitate Metal – Imido Bond Formation

ACS National Meeting - March 2005 – San Diego, CA

Dr. Goodwin	Christina N. Barnes	A Synthetic Approach to Lamellarins, Marine Natural Products
	Patrick A. Brown	Comparison of Different SPME Fibers for the GC-MS Analysis of Trace Organics in a Biological Matrix (Urine)

Faculty mentor	Student	Title of presentation
	Mindy S. Eggert	Use of SPME, Reverse Phase SPE, and GC-MS in a Search for African Elephant Urinary Pheromones
	Courtney Rogers[1]	Large Scale Synthesis of a Highly Functionalized Indole
Dr. Teague	Charles F. Zehm	Hybrid Rocket Motor Plume Temperature and OH Radical Profile by UV Spectroscopy
Dr. Hales	Catrin M. Mills	Photodissociation of Boron Bromide Cluster Ions Formed by Electron Ionization of Boron Tribromide Clusters
	Shawna M. Rigsby	Photodissociation of Boron Bromide Cluster Ions from a Discharge Ion Source
Dr. Gron	Sean M. Davenport	Simple Environmental Analytes with Important Consequences: Ion Chromatography for Introductory Chemistry Students
	Jeffery W. Herrold	Monitoring the Cyclopentadiene Dimerization in High Temperature Water
	Andrew T. Nguyen	Ion Chromatography for Green Environmental Analysis
	Robyn L. Poerschke	Diels-Alder reactions in High Temperature Water
	Benjamin Weeks	Manipulation of Reactions in High Temperature Water
Dr. Willis	Walker Dyer	Comparison of Different Storage Protein Gene Activities in Anautogenous and Autogenous Adult Mosquitoes

NCUR – April 2005 – Washington and Lee University

Dr. Goodwin	Maria Evola	Use of SPME, Reverse Phase SPE, and GC-MS in a Search for African Elephant Urinary Pheromones