Department of Physics and Astronomy Self-Study Executive Summary

The learning goals for physics majors at Millikin University are:

1. Students will solve complex problems that require integrating knowledge from a variety of subfields, including classical mechanics, classical electrodynamics,

the Leighty-Tabor Science Center (LTSC), which opened in 2002, and provides an adequate facility for the teaching of physics. The department is also in the process of submitting a grant proposal designed to upgrade our astronomy/astrophotography equipment to enhance education, research, and outreach.

The number of students who are physics majors has grown significantly over the past three years. As of Fall 2004, there was one sophomore and three freshmen physics majors. In Spring 2008, we graduated our first class in five years, and each of the four graduates is expected to attend graduate or professional school in the fall, either in Physics, Chemistry, or Engineering (including one student at Washington University as part of the dual-degree program). In Fall 2008, we expect to have three seniors, three juniors, three sophomores, and five to six freshmen enrolled as physics majors.

Most students who pass through courses in Physics or Astronomy are not physics majors, and therefore serve as evidence for
addition, because of the excellent astronomical equipment that the University has, the department serves the community by offering regular public viewings at the Requarth Observatory, as well as nu

Theoretical and Applied Mechanics (PY 352) and Quantum Mechanics (PY 406), along with their Senior research project (PY481/482). The relative absence of physics courses from the senior year is intentional, so that students preparing to take the GRE in the fall of their senior year are as prepared as possible.

During their junior year, Physics majors would take PY 262, Experimental Physics I focusing

industry and academic standard in experimental control and data acquisition. In the spring, they would take PY 362, Experimental Physics II, where they would focus on data acquisition and experimental design. These courses are where students will first experience substantive experimental design, and will also involve instruction in writing of scientific papers. The courses will culminate in seminar-style presentations that will be open to other physics majors, minors, and faculty. Similar presentations will occur at the end of the junior and senior years, at the end of which students will present work from a senior research project. In addition, they will complete the two-term Electrodynamics sequence (PY 403/404).

Along with these courses will be a number of math and other science classes, such as Physical Chemistry (cross-listed with Chemistry), depending on student interest and career goals. These courses are primarily theory-based, and will involve extensive integration of material from a variety of classes and fields.

A key component of the Physics program at Millikin is that each student will design their own major, in consultation with their advisor and any other relevant faculty. This will allow for greater flexibility in the curriculum, which experience shows is highly desirable to many students. Because of the flexibility in the program, advising is especially important. Since

through Millikin, a process of regular reflection on what he or she has done and want to do is necessary to make the courses fit specific needs. The department has designed documents to help students through this (s)5(pe)-2(ci)-3(≤k20 0 1 422.cwa)-6h8a5.05 T3(or)3(grea)-5(ter f)5(ic)-6h8a5.05 T3

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Pre Test)*100. This allows us to compare the improvement of students who begin the course with different backgrounds. Data has been collected from thousands of classes at dozens of universities over the last decade, and results for different pedagogical methods are well known. Courses utilizing primarily traditional, lecture-based pedagogies average a 23% gain, while courses utilizing primarily active learning methods average a 48% gain.

The department goals for the FCI are as follows:

2) PY majors, at the end of their sophomore, junior, and senior years, will take the Physics Major Field Test, administered by the Educational Testing Service. The MFTs were introduced in 1989, and are given, in a variety of disciplines, at over 700 colleges and universities (including the MU Chemistry department). The scores will be tracked over the (up to) three years that students take the exam, and progress will be measured both on how individual students improve as well as how MU students compare to national results. There are three scores reported by ETS a Scaled Score, ranging between 120 and 200 (2004 median score for seniors 144), an Introductory Physics Score, ranging between 20 and 100 (2004 median score for seniors 44), and an Advanced Physics Score, ranging between 20 and 100 (2004 median score for seniors 46).

It is expected that students will improve as they progress through Millikin, so that a satisfactory result for a sophomore would be lower than that for a junior, etc. The departmental goals for each of the three courses are listed below (in terms of average percentile ranking for the

Item	Criteria

Written Presentations:

	Excellent	Adequate	Nominal
Clarity of Writing	[5 points] Clear logic and structure of paper. Strong command of language, spelling, and grammar. Clear confidence in command of material. Easy to read.	[3 points] Overall, a solid paper, but fails to meet a significant amount of criteria for excellence. Could use proofreading.	[1 point] Poorly organized paper no clear structure or logic. Poor grammar or spelling. Difficult to understand and read.
Length and Appropriateness of paper	[5 points] Length of paper appropriate for forum or meets assigned criteria. Included enough material to keep paper consistently strong, but not too dense. No filler. Paper aimed at appropriate audience professional, classmates, general audience, etc. Humor, etc, takes into account audience level and composition.	[3 points] Paper a little too long or too short, but otherwise lacking filler and not too dense. Generally appropriate level of writing, but at times above or below heads of audience. Some remarks perhaps inappropriate for audience.	[1 point] Significantly too much or too little material of substance. Failed to take audience into account when writing.
Demonstration of understanding of physics	[5 points] Clear understanding of subject and definitions of presentation-specific terms. Insight into material b found in references. Defined terms at appropriate level of depth and complexity. Subtleties included only when necessary.	[3 points] Shows some command of material and understanding of material obtained from references. Failed to define some necessary terms. Failed to meet a significant amount of criteria for excellence.	[1 point] Understanding of material clearly lacking. Does not understand basic definitions of terms used. No insight.

It is expected that students will improve as they progress through courses, so that a satisfactory result for a student in PY 253 would be lower than that for a student in PY 362, etc. The departmental goals for each of the three courses are listed below:

PY 253
PY 362
PY 481/2

V. Data

For goal 1, the FCI was administered during Fall 2007 to twenty-eight PY 151 students. The average pre-test score was 7.9 (down from 9.4, 9.0, and 9.1 in 2004, 2005, and 2006), the average post-test score was 13.5 (significantly down from 16.3 in 2005 and 17.0 in 2004 but

For goal 2, we did not apply the above rubric to the experimental designs in PY 253 or PY 362. We are rearranging some of the curriculum (as mentioned above), and in the future, those courses will include a more deliberate focus on experimental design than they currently do. We expect to have data on this in the 2009 report.

For goal 3, we applied the above rubrics for written and oral presentations to students in PY 253, PY 362, and PY 404 (comparable with PY 362 in expectations). The results were as follows:

PY 253: Written Average = 9.6 (8.7 in 2006) Oral Average = 10.5 (10.8 in 2006)
PY 482: Written Average = 14.3 (first year for this level) Oral Average = 14.5

VII. Improvement Plans

Goal 1: As noted above, we expect the FCI scores to continue to improve in Fall 2008, as Casey Watson develops and refines his teaching skills. In Fall 2007, he attended the New Faculty Workshop, presented by the American Association of Physics Teachers and sponsored by the National Science Foundation in November. (Eric Martell attended in 2004.) At this workshop, he was given in-depth training in research-based pedagogies presented by the leading researchers in the field of Physics Education. The students in PY 151 showed improvement from 2006 to 2007, and similar improvement in 2008 would move this rating up to yellow.

In the 2007-2008 AY, we focused more of our efforts on training our students to deal with multiple-choice tests, as they will see on the GRE (for example). The MFT is designed to correlate with the Physics subject section of the GRE, so not only does it measure our students against nationally established baseline, but it also relates to their ability to get into graduate school. In prior years, the MFT was the only multiple choice test they saw all year, as we focus on problem solving and integration of knowledge. Our improvement plans included two things a series of voluntary tutoring sessions for students planning on taking

for the test, as well as the integration of some multiple-choice questions, taken from GRE practice books and similar texts, into each advanced course, including instruction on how to approach the questions. We strongly believe that the problem-based approach produces stronger physicists; however, the GRE (and similar tests) is a necessary hurdle for students interested in advanced study, and our data now indicates a significant improvement in their performance on the MFT. We will h ques5640406(T)5pproach the quel h que(ifica5640 0 0e3(s)5(ign)-2(ifica)-5()

Appendix I Curriculum Map

	Problem Solving	Experimentation	Communication
PY 100 The Planets			
PY 101 Stars and Galaxies			
PY 104/105 Lab			
PY 106 Physics of Sports	YES		
PY 111/171 College Physics I PY 112/172	YES		