Part I: Department Mission (taken from our last APAC self-study (MOU signed in fall of 2010):

The Physics Department recognizes and adopts the student objectives in the Juniata College Mission Statement. The department believes it contributes in a planned way to the following skills identified in the Statement:

- read with insight
- use language clearly and effectively
- think analytically
- understand methods and purposes of academic inquiry
- demonstrate creativity

The department supports the values – spiritual, aesthetic, and moral – which the educational enterprise pursues even though the implementation of these values at the departmental level is relatively unstructured in the courses. Such values are expressed by each faculty member either in courses or in other contacts with students.

Since the pursuit of physics is a social phenomenon, and has been since the 17th Century when scientific societies were formed and scientific journals initiated, the department contributes to the following community values in the way it implements its programs:

- mutual support
- free exchange of ideas
- pursuit of both cooperative and individual achievement
- capacity to promote diversity

In addition, the department recognizes an emergent threat from evidence that in our society there is widespread scientific illiteracy, including a lack of understanding of the nature of scientific inquiry and basic knowledge, and apathy toward understanding the achievements of the human intellect. In a recent article[1], the author argues that, "Industrial democracies cannot survive unless their citizens are scientifically literate." He cites the following definition of scientific literacy which is attributed to Jon Miller, professor of Interdisciplinary Studies and Director of the International Center for Scientific Literacy at Michigan State University, who has systematically studied worldwide scientific literacy for the past twenty years:

> "[Scientific literacy is] the level of understanding of science and technology needed to function in a modern industrial society. This … does not imply an ideal level of understanding, but rather a minimal threshold level."

The author concludes that all nations "should require college students to take at least two or three science courses designed for general scientific literacy." Although the College does not require every graduate to take even one science course, among our specific goals in teaching physics are helping students develop correct methods of physical analysis and leading them to appreciate both how far we have come intellectually in the explanation of natural phenomena, and at the same time how much remains wondrous and unknown. This includes the development of critical reasoning, i.e., exercising healthy skepticism, to discern sense from nonsense, and science from pseudo-science. It also includes awareness that assertions about the physical universe must be supported by empirical evidence, and that scientific understanding requires continued substantiation and is subject to modification in the face of new data. Science does not purport to claim that our knowledge of the physical world is complete and infallible. However, it does take odds with attributing unexplained physical phenomena to the realm of superstition, religion, magic and pseudo-science. Beyond this, the department believes that we must prepare students who can carry the educational mission of greater scientific literacy beyond the college walls after they graduate.

Not to be taken lightly is the College Mission Statement reference to preparing students to lead useful lives and to contribute to their fullest potential to society. For the department this means that the subject matter we teach and the skills we develop are relevant to the student's capacity to obtain employment in an occupation that is considered essential in our economic and social community.

1. Art Hobson, "The Surprising Effectiveness of College Scientific Literacy Courses," *The Physics Teacher*, **46**, 404-406 (Oct. 2008).

1. Goal/Outcome

To have students develop an understanding of the content of, and interrelationships between, the different areas of physics, including mechanics, thermodynamics, electricity & magnetism, optics, nuclear theory, relativity and quantum theory. Assessment question: Are our students exposed to, and mastering, the content in physics?

1. Strategy

i) Offer appropriate core courses for physics-related POEs, and service courses for associated departments.
ii) Keep our introductory physics courses small, limiting size to fewer than 50 students whenever possible.
iii) Offer numerous out-of-class help opportunities from both faculty and physics majors.
iv) Offer plenty of timely feedback in the form of an online homework management system, in-class conceptual quizzes using remote response, and hand-graded tests and problem sets.
iv) Employ interactive teaching and active engagement techniques to keep students mentally invested during class.

1. Assessment Methods

i) Evaluate via assessment of coursework (exams, papers, presentations, lab notebooks, etc). Further evaluation of majors occurs using two standardized field exams administered annually, one for lowerclassmen (Force Concept Inventory and/or Mechanics Baseline Survey) and one for upperclassmen (ETS Field Test).
ii) GRE subject test in Physics for students aspiring to graduate study.
iii) MCAT "Physical Sciences" section for students, both majors and non-majors, who hope to attend medical school (MD/DO)

1. Assessment Results

i) Our highest achieving students at JC also perform better on the ETS exam than do our other students. For those students who took the exam as juniors and again as seniors, scores in both subcategories, Introductory Physics and Advanced Physics, improved by roughly 11% and 9%, respectively.
ii) The Physics GRE subject test is taken by very few of our students (so probably not a large enough N to use as an assessment instrument) and they do not do particularly well. This is consistent with results on the ETS Field Exam. This has a lot to do with the limited number of advanced courses students have in the content areas when taking the tests. However, there have been significant improvements in the last couple of years. We attribute much of this to starting to offer a Thermal Physics course every other year after having not offered such a course in well over a decade. We have also offered Optics every other year after having gone about five years of not offering it. Over the past decades the Chemistry Department has offered Quantum Mechanics, a course which resides in Physics in virtually all other colleges. Starting this year, we will be offering Quantum Mechanics on an "every other year" basis. Electricity & Magnetism, as well as Mechanics, is only offered every other year, so a student will not have completed both of these before taking the GRE in their Junior or Senior year.
iii) The "Physical Sciences" section of the MCAT comprises both Inorganic Chemistry and Physics. As such, this is not an ideal assessment instrument as there is no mechanism to segregate performance in the two areas. A table showing the performance of Juniata students, and the national average, on this particular section is given below. The table counts each score of students who retake the exam due to a poor first performance. A standard deviation is roughly +/-2. It should be noted here that over the last 5 years we have offered an optional MCAT review course to pre-med students for which department personnel provide instructional support. JC students have performed at the national average over this time frame, and those students taking the prep course score significantly better than those not taking it. While this is anecdotal evidence, it suggests this prep course does help students prepare for the Physical Sciences section of the exam.

MCAT Date	JC sample size	JC PS	Natl PS
Apr 00	10	**8.7**	8.2
Aug 00	3	**8.3**	8.2
Apr 01	15	**8.5**	8.3
Aug 01	11	**9.4**	8.2
Apr 02	10	8.2	8.2
Aug 02	8	**8.4**	8
Apr03	11	7.6	**8.1**
Aug 03	11	7.4	**8.1**
Apr 04	11	8.5	8.1
Aug 04	2	**10.0**	8
Apr 05	14	**9.1**	8.2
Aug 05	5	7.0	**8.1**
2006	20	7.1	**8.3**
2007	26	7.9	**8.5**
2008	12	**8.8**	8.2
2009	30	**8.5**	8.3
2010	14	**9.0**	8.3
Weighted average		**8.3**	8.2

1. Assessment Impact

i) Based on data from the ETS field test and the GRE subject test, we have restructured our major's upper-level course offerings, although we would like to do even more if resources become available. We will be starting to offer Quantum Mechanics, taught by a Physics professor rather than a Chemist. Our intention is also to offer an advanced Astrophysics or Observational Astronomy course every other year.
A freshman-only course is offered in a studio-physics style to better support and stimulate the freshman who intend to be physics or engineering physics POEs. The creation of this course is a direct outcome of our assessment over the past five years. The first year of this course was in 2010. This course was a great success when it came to improving the learning of physics and engineering students. The freshman course and Introductory Physics (which freshman have taken in earlier years and all Chem and BioChem students, as well as some premeds, continue to take) took the same final exam in 2010. The freshman averaged 6.2% higher than the upperclassman. Data from earlier years indicate that when the freshmen were in Intro Physics, they typically did a few percentages below the upperclassmen. In addition, no freshman dropped the course mid-semester, where it is typical to have a couple drop (and so…those students would not have taken the final exam). The results are dramatic. Was this a particularly good freshman class? We don't think so, but future years will tell.

Although the outcomes of the freshmen were dramatic (with a freshman class average on the final exam about 8% better than would have been predicted from earlier years when they were in Intro Physics), the retention in Physics and Engineering has not improved. That is, about the same number of students that have moved to a different POE as one would have predicted from earlier years. But there is a dramatically different story to be told. Although the same number of students have switched to other POEs, they have moved to other POES because of their interests and goals (or poor performance in Calculus), rather than out of desperation for their grades and understanding in physics. I think that it is far less likely that these students will consider leaving Juniata and I think many of them will result in Latin Honors in other departments, having not bombed their first term in physics. (Although, some have still hit major stumbling blocks with Calculus…which is a co-requisite with physics.) This finding is consistent and a continuation with the department's belief that we are an important department at Juniata for attracting students. The number of students that come to Juniata because we have a strong physics and engineering department will always be larger than the actual number of graduates in those fields.

We were not able to gain a lot of comparison in the student evaluation forms. Both the University Physics and Intro Physics courses rated the overall average around a 4.5 with a bit more than half

rating “SA” overall. But then, the freshman course included lab. A comparison of the student evaluations of the freshman course to colleagues’ evaluations of the corresponding lab course (PC206) shows a much higher satisfaction among the freshman.
ii) Interactive lecture demonstrations have been added to General Physics to increase student engagement and promote in-class critical thinking exercises.
iii) We continue to contribute substantially to the MCAT and GRE prep courses on campus. As a measure of success, students taking the prep course have outscored those not taking it. Over the past three years Juniata students have significantly outperformed the national average on the Physical Sciences section. Through the College’s Health Professions Committee, we have begun to administer and participate in pre and post prep course assessment to better gauge its impact and efficacy.

2. Outcome/Goal

To offer Programs of Emphases (Physics and Engineering Physics), as well as a Secondary Emphasis, which give students the flexibility to explore their interdisciplinary interests.

2. Strategy

i) Limit course requirements in the POEs
ii) Aggressive and realistic advising
iii) Maintain strong relations with other departments, particularly Mathematics and the other natural sciences.
iv) Include seminar speakers from other departments
v) Keep the physics student lounge open to students from other disciplines who have an interest in physics
vi) Encourage study abroad and publicize interdisciplinary opportunities within the sciences.

2. Assessment Methods

Track the number of physics students with multiple POEs and with Secondary Emphases in other fields. Track the number of students with Secondary Emphases in Physics. Track our students’ participation in study abroad programs.

2. Assessment Results

During the fall of 2011, the Physics Department has 23 JR and SR students with “physics” appearing in their POE title, and several additional students that have a secondary emphasis in physics. (We did not include lower classmen in these numbers as we lose a number of FR and SO students due to the rigor and mathematical demands inherent in the program). Of these students,

- 3 have or will be studying abroad for a semester or year;
- 8 have interdisciplinary or double POEs with physics and another department (Mathematics, French, Education, Chemistry, Biology, Geology);

2. Assessment Impact

i) Many of our students find that study abroad does not mesh well with their physics upper-level courses as many of these courses are offered on an every-other-year basis, some of which are required in the POE. We have been very flexible with course substitutions, but students looking toward graduate school have been constrained by our limited, in both content and sequencing offerings. We entertain the idea (and discussed by our last outside review team from our last APAC self-study) of offering advanced courses more often. But, staffing shortages and perceived pressure to keep class enrollment up have kept us from pursuing this direction.
ii) We continue to have many students with multiple interests succeed at complete interdisciplinary programs due to the limited number of specified advanced courses in our POE. Students preparing for graduate school in physics are more likely to have a double or secondary POE with Mathematics than with any other field.

iii) We have dedicated sessions in our weekly fall-semester physics seminar, required of all POEs, to promote study abroad and to briefly discuss a number of diverse opportunities for someone with a degree in Physics.

3. Outcome/Goal

To prepare students for success in their future studies and professional careers.

3. Strategy

i) Offer appropriate course work for 3-2 engineering students, engineering physics students, and physics students (including those aspiring to teach physics at the high school level).
ii) Offer appropriate research opportunities and/or encourage application for research/internship opportunities at other institutions/businesses for 3-2 engineering students, engineering physics students, and physics students (including those aspiring to teach physics at the high school level).
iii) Provide opportunities for student presentations in some courses.
iv) Encourage students to present their research findings on-campus (e.g., during physics seminar and/or at the annual Liberal Arts Symposium).
v) Encourage students to present their research findings off-campus (e.g., at AAPT, APS, or NCUR meetings).
vi) Through Physics Seminar, expose students to successful scientist, engineer, and graduate student role models, including JC alumni; inform students about study abroad opportunities; discuss science/engineering ethics with students; familiarize students with graduate school, internship, and research opportunities and application processes.

3. Assessment Methods

i) Determine whether or not our students qualify for transfer to our engineering agreement schools, for graduate programs in physics, for high school teaching positions, and for other jobs in areas of their training.
ii) Determine whether or not those students who seek research opportunities or internships are successful at securing such positions.
iii) Review annually which course offerings require student presentations and what presentation techniques are employed.
iv) Review annually which students who engaged in research presented their findings on-campus and/or off-campus, and at what meetings or conferences the presentations were made.
v) Review annually the Physics Seminar syllabus and accomplishments, student summaries of speakers/presentations, and course evaluations to insure that the course is meeting its intended goals.

3. Assessment Results (2011)

i) Of the seven graduates in 2011, five are in graduate school. Two are in physics programs, one in medical physics, one in optics, and one in seminary. The other two students have not yet surfaced. One completed the 3-2 engineering program with Penn State and the other was having visa problems and withdrew his applications to graduate school last spring. All students, with one exception, achieved their immediate post-Juniata goals.
ii) Seven students successfully applied for summer (2011) research positions or internships. They worked at Metaldyne, National Institute of Standards and Technology, Harvard, University of Rochester, SUNY Stony Brook, and Pacific Northwest National Laboratory (PNNL).
iii) Student presentations occurred in Modern Physics, Advanced Lab, and Research
iv) Five of the summer (2011) research students and one intern presented their work during Physics Seminar. (The seventh student is studying abroad.) In addition, students will presented at the annual Liberal Arts Symposium, and other conferences.

3. Assessment Impact

We have reviewed all of our course offerings and our POEs. Fundamentally, our program is sound, but we must continue to provide, and even expand upon, upper-level course offerings.

We must also continue our effort to identify the optimal sequence of upper-level course offerings given our restricting number of FTE faculty. Our POEs have been slightly modified in an effort to more clearly articulate the requirements for engineering physics students and those who wish to pursue careers in secondary teaching.

A few years ago we moved Physics Seminar from the spring semester to the fall semester. This change permits us to integrate freshmen more quickly into departmental activities, to discuss graduate schools and graduate school application procedures in a more timely fashion, and to inform students about research, internship, and study abroad opportunities earlier in the academic year. We feel as though our approach to seminar is effective, and we plan to continue offering it in the same format for the foreseeable future.

4. Goal/Outcome
   - To craft an environment that will inspire students' sense of pride in the Physics Department, its facilities, and in their individual accomplishments in physics.
   - To encourage camaraderie and diversity; to provide an environment conducive to learning and collaboration among students.

4. Strategy
   - Maintain SPS (Society of Physics Students) Lounge as student work and social space; utilize this space to draw minors as well as majors into the Department;
   - Work with Facilities Services and the administration to upgrade the P-wing of BAC in targeted, high-impact areas;
   - Highlight and visibly promote alumni accomplishments;
   - Hold casual departmental events to facilitate department cohesion and interaction;
   - Utilize the Physics Seminar course to advance these goals;
   - Promote the inclusion of non-tenure track instructors in departmental planning and activities, and use these positions to advance diversity and breadth in our curricula;
   - Use the SPS club as the core of student cohesion and activity;
   - Give students important responsibilities in select departmental affairs

4. Assessment Method(s)

   We have no systematic or concrete assessment in this area, only anecdotal and observational.
   - How is our SPS chapter recognized by national SPS organization? Do our students garner national recognition via awards or scholarships?
   - Do students attend non-compulsory departmental (social) and SPS (social and outreach) events? Are freshmen well represented at these events?
   - What is the impact of having a woman (Mary Atchley) in the Department and in charge of lower-division lab courses? Of having a foreign national (Mark Pearson)? Of having full-time faculty (White/Siems/Borgardt) who have all had academic posts overseas?
   - How do students view the physical space the Department occupies?
   - What is the impact of giving students responsibility in departmental affairs?

4. Assessment Results
   - Our SPS chapter has been recognized by the national organization as an "Outstanding Chapter" for 911years running – only 2% of chapters are nationally given this designation in any given year. Our students have done well in garnering individual awards from this national organization as well.
   - The student lounge is highly used by both physics majors and minors and plays a inestimable role in attracting prospectives and in the camaraderie of students
   - The diversity of our staff is visible support of our support of diversity issues and study abroad. For instance, students feel at ease in coming to Mary Atchley for help in physics courses, and she plays a vital middle ground between other faculty (who students may – mistakenly – view as intimidating) and student TAs (whose foundational understanding of physics is still being developed). We also typically have had 33% female students in

physics, so Mary's presence is supportive in that capacity as well, as are seminar talks by female alumni and outside researchers.

- We have identified and targeted several high-use or very visible academic and social spaces for renovation.
- Our support of diversity is attested to by having recently had a number of homosexual, transgendered, and minority religion (Pagan, Wiccan) students spending significant time in our wing. Such students have felt able to approach department faculty with issues they face in this regard. We even converted our men's restroom into a unisex bathroom in response to the needs of, and in support of, certain self-identified diverse students.

4. Assessment Impact
    - The Bill Phillips Lobby and Lounge, with the Nobel Prize display, has been completed and provides a much nicer and more inviting entrance to our wing. This is particularly important for Enrollment tours, visits by prospectives, and the inspiration of our own students.
    - Over the last (20011) summer our small classroom was renovated and the main corridor was painted. This is a continuation of a long-term plan with facilities to spiff up a few spaces in the physics wing each summer. While the associated improvements (general clean up, painting, removal of some temporary partitions, addition of artwork) may seem minor, they have provided a more warm, inviting, and student-friendly lab space. We have noticed students spending more time in these spaces and attribute this to these physical changes.
    - We continue to hold an annual Departmental picnic, and have been progressively more successful at getting FR students to attend. This increased participation of new students is one important impact of moving the Physics Seminar to the Fall semester.
    - The student P-wing lounge is a hub of student activity, and its importance to our Department cannot be overstated. It is central to our ability to attract and retain students, and functions as an ideological staging area for diffusion of Departmental goals on diversity and professional development.
    - We permit, and to some extent encourage, the use of P200/201 as open computer labs. This space is used by physics majors and minors, and also by students in the two two-semester introductory physics sequences. This increases the visibility of, and activity within, our department. The Juniata computer network now recognizes this use and has installed a large network multi-use printer.
    - Our support of our student SPS chapter continues to pay dividends as the core national organization about which student activity is structured. It has provided an important avenue for promoting professional development, internships and students' perceptions of their role as part of a wider physics community.