Weber State University
Annual Assessment of Evidence of Learning

Cover Page

Department/Program: Physics
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A. Brief Introductory Statement:

Please review the Introductory Statement and contact information for your department displayed on the assessment site: **http://www.weber.edu/portfolio/departments.html** - if this information is current, please place an 'X' below. No further information is needed. We will indicate "Last Reviewed: [current date]" on the page.

__X_ Information is current; no changes required.
___ Information is not current; updates below.

Update:

B. Mission Statement

Please review the Mission Statement for your department displayed on the assessment site: **http://www.weber.edu/portfolio/departments.html** - if it is current, please indicate as much; we will mark the web page as "Last Reviewed [current date]". No further information is needed.
If the information is not current, please provide an update:

__X_ Information is current; no changes required.
___ Information is not current; updates below.

C. Student Learning Outcomes

Please review the Student Learning Outcomes for your department displayed on the assessment site: **http://www.weber.edu/portfolio/departments.html** - if they are current, please indicate as much; we will mark the web page as "Last Reviewed [current date]". No further information is needed.
If they are not current, please provide an update:

_X__ Information is current; no changes required.
___ Information is not current; updates below.

Measurable Learning Outcomes

At the end of their study at WSU, students in this program will:

1) …
2) …
3) …
4) …
5) …
6) etc.

D. **Curriculum**

Please review the Curriculum Grid for your department displayed on the assessment site: **http://www.weber.edu/portfolio/departments.html** - if it is current, please indicate as much; we will mark the web page as "Last Reviewed: [current data]". No further information is needed.
If the curriculum grid is not current, please provide an update:

_X__ Information is current; no changes required.
___ Information is not current; updates below

Curriculum Map

Core Courses in Department/Program	Department/Program Learning Outcomes							
	Learning Outcome 1	Learning Outcome 2	Learning Outcome 3	Learning Outcome 4	Etc…			

Note[a]: Define words, letters or symbols used and their interpretation; i.e. 1= introduced, 2 = emphasized, 3 = mastered or I = Introduced, E = Emphasized, U = Utilized, A = Assessed Comprehensively; these are examples, departmental choice of letters/numbers may differ
Note[b]: Rows and columns should be transposed as required to meet the needs of each individual department

Additional Information (if needed)

E. Assessment Plan

Please review the Assessment Plan for your department displayed on the assessment site: http://www.weber.edu/portfolio/departments.html - if the plan current, please indicate as much; we will mark the web page as "Last Reviewed [current date]". No further information is needed.

The site should contain an up-to-date assessment plan with planning going out a minimum of three years beyond the current year. Please review the plan displayed for your department at the above site. The plan should include a list of courses from which data will be gathered and the schedule, as well as an overview of the assessment strategy the department is using (for example, portfolios, or a combination of Chi assessment data and student survey information, or industry certification exams, etc.).

Please be sure to include your planned assessment of any general education courses taught within your department. This information will be used to update the General Education Improvement and Assessment Committee's planning documentation.

Assessment plan:

The plan is current. No changes at this time.

F. Report of assessment results for the most previous academic year:

A. Evidence of Learning: Courses within the Major

Our assessment efforts this year were focused on our General Education courses, which were all up for renewal of PS status in Fall 2016. Please see section C for details.

B. Evidence of Learning: High Impact or Service Learning

Our students all complete our capstone *PHYS 4990* seminar course in order to graduate. Typically they report on an undergraduate research project they have completed prior to registering for that course. Depending on which option students pursue within the major, they may have an additional *PHYS 4800* research credit requirement.

Apart from *PHYS 4990* and *PHYS 4800*, we have a lot of high impact or service learning opportunities for our students that have been documented elsewhere. These include some elements of our upper division courses, the HARBOR program, the annual Physics Open House, Science in the Parks, and SI positions, to name some examples.

C. Evidence of Learning: General Education Courses

Over the past year, Department assessment efforts have been focused on General Education Physical Science (PS) goals, objectives, and outcomes. Towards this effort, instructors of these courses have discussed and planned more systematic measurements than we've had in the past, and these were most recently reported in our General Education renewal for all our PS courses. In the coming year, we will be using this same strategy for evaluating courses and student success in our majors.

The most recent of our General Education assessments is presented below, each course in its respective grid.

More important than these particular outcomes, we've recognized current strengths and weaknesses of the current assessment measures. These will inform future assessments and course designs. First, we have drawn from assessments that are natural and authentic components of a course. That is, there is a "natural habitat" of each course (conceptual astronomy versus a problem-solving physics course, for example) that provides a rich context for more general outcomes. In a problem solving course for science majors, students solve problems that connect energy transformations within a system in order to predict a specific result; yet in a conceptual course a student may need to narratively describe the source of the Sun's energy during solar system formation. We've determined that there are very specific concepts that match the more general outcomes, and moreover there are very specific tasks that we engage students in different coursework. These all are assessed differently.

At the same time, some assessments are better than others. While we think that most of our assessments are "direct," there are probably different levels of such directness. And, some measures are simply better than others. We know, for example, that a student can solve problems that require an understanding of force at some level, but they may not be able to use that understanding in other contexts. This might seem like a damning evaluation of a particular assessment method, but we see that this is a weakness across the board. In fact, all assessments suffer this weakness. Rather than brush it aside, we're embracing it and using this to further our work. That's a much longer process. (The most used research instrument in physics education research, the Force Concept Inventory, has items that have been used for three decades, but the meaning of these is still scrutinized and debated.)

Finally, we're pleased that there are measures here that we think are potential models to build from because they are particularly well aligned with outcomes and simultaneously provide a valid measure of deep learning. For example, we're able to pull data about student thinking in readings of historical literature in an introductory physics class; we can evaluate student understandings of scientific practices in laboratory environments; we have demonstrated how students compile and evaluate data to construct scientific models (e.g., solar system formation data in astronomy courses); students demonstrate understandings of the nature of science by testing their own scientific explanations and reflecting on the process itself; and many others. These kinds of measures are not simply measures, but part of the curriculum of a given course that helps students to learn science in meaningful ways.

As we move forward with other assessment efforts in the major as well as in general education, we'll be considering these "lessons learned."

Elementary Physics, PHYS 1010 (Spring 2016)

Gen Ed Learning Goal Students will demonstrate understanding of:	**Measurable Learning Outcome** Students will demonstrate their understanding by:	**Method of Measurement** Direct and Indirect Measures*	**Threshold**	**Findings Linked to Learning Outcomes**	**Interpretation of Findings**	**Action Plan/Use of Results**
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will identify features of a testable scientific claim and provide examples of how scientific knowledge changes.	First HW and Quiz 1 questions	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students (66/85) are "proficient," and almost all students are "mostly proficient" (82/85).	Students are meeting this learning outcome.	No action plan.
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will relate gravitational forces of "earth-bound" to astronomical systems.	First HW and Quiz 1 questions	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students (66/85) are "proficient," and almost all students are "mostly proficient" (82/85).	Students are meeting this learning outcome.	No action plan.
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Students will analyze the historical and societal implications of scientific work as presented in biographical/historical reading and case study.	Reading, discussion, and quiz on Oppenheimer biographical text.	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	49/78 students were proficient.	Students are meeting this outcome.	No action plan.

Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	Students will examine and analyze data to make a prediction or solve a problem.	Multiple, especially including heat energy question and calculation.	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	34/67 students were proficient; 55/67 students were mostly proficient.	Students are meeting this outcome with less frequency on this outcome than on others and some improvements could be made.	Incorporate more "real data" examples in the course and student work.

Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Students will analyze data to determine general rules that define a physical system.	Multiple throughout the course, and the basis of the entirety of Exam 1.	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	50/80 students were proficient; 71/80 students were mostly proficient.	Students are meeting this outcome.	No specific action plan, but departmental conversations continue to take place around developing teaching and assessment tools for this outcome.
Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students must identify are considering basic properties of matter, such as mass and its effect on changes in motion.	Multiple throughout the course, and the basis of the entirety of Exam 1.	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	50/80 students were proficient; 71/80 students were mostly proficient.	Students are meeting this outcome.	No specific action plan, but departmental conversations continue to take place around developing teaching and assessment tools for this outcome.
Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students must identify transformations of energy in physical systems, and predict outcomes of such energy exchanges.	Multiple throughout the course, and the basis of the entirety of Exam 1.	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	50/80 students were proficient; 71/80 students were mostly proficient.	Students are meeting this outcome.	No specific action plan, but departmental conversations continue to take place around developing teaching and assessment tools for this outcome.
Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students will identify the forces contributing to equilibrium and/or predict changes in motion resulting from unbalanced forces.	Multiple throughout the course, and the basis of the entirety of Exam 1.	On quizzes/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	50/80 students were proficient; 71/80 students were mostly proficient.	Students are meeting this outcome.	No specific action plan, but departmental conversations continue to take place around developing teaching and assessment tools for this outcome.

Elementary Astronomy, PHYS 1040 (Spring 2016)

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will examine data and form and test hypothesis based on these data.	"51 Pegasi: The Discovery of a New Planet" assignment. Students must demonstrate understanding of testable hypothesis and appropriately analyze relevant data.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students are proficient, with an average score of 76%.	Students are meeting this learning outcome.	No action plan.
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will apply physics of "earth-bound" systems to novel astronomical systems.	"Measuring the Mass of Earth" hands-on assignment requires students to apply Newton's Universal Law of Gravitation to a falling object to calculate the mass of Earth.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	All students are proficient, with an average score of 98%.	Students are meeting this learning outcome.	No action plan.
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Students will analyze the historical implications of an astronomical discovery and evaluate the societal value of future scientific work.	"Habitable Worlds" in-class assignment requires students to explore the implications of discovering life elsewhere in the galaxy and craft a defendable argument for such research.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on the assignment was 67%.	While there is formative in-class assessment that suggests there's better understanding, we generally observe that students need more explicit experiences in connecting science and technology to societal implications.	Develop more assignments to explicitly draw this society connection as related to the search for life in the universe.
Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	Students will examine data and form and test hypothesis based on these data.	"51 Pegasi: The Discovery of a New Planet" assignment. Students must demonstrate a mathematical analysis, application, and graphical representation of empirical data.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students are proficient, with an average score of 76%.	Students are meeting this outcome.	No action plan.

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Astronomy is, at its heart, an an analysis of systems that are described by physical law. Students will analyze data to determine general rules that define a physical system.	"Hubble Law" lab: students analyze real empirical data that provide evidence of universal expansion when time is played "in reverse", which prompts them for an argument for Big Bang.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students are proficient, obtaining an average of 80% on the Hubble Law lab.	Students are meeting this outcome.	No action plan.
Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students must identify are considering basic properties of matter, such as mass and density, and must be able to distinguish astronomical scales.	Planet Formation Activity assignment: students must apply physical law to argue how matter organizes from large scale clouds of dust and gas into stars and planets.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students are proficient, obtaining an average of 80%on the assignment.	Students are meeting this outcome.	No action plan.
Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students must identify transformations of energy in physical systems, and predict outcomes of such energy exchanges.	Indirect: In-class formative assessment of students ideas about sources of stellar energy. Direct: "Spectroscopy" assignment requires students to identify and characterize the transformation of collisional energy to radiative energy in order to complete the task.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Most students are proficient, obtaining an average of 81%	Students are meeting this outcome.	No action plan.
Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students will identify the forces contributing to equilibrium in astronomical systems.	"51 Pegasi: The Discovery of a New Planet" and "Mass of Jupiter" assignments. Students must identify gravitational forces and their relation to planetary motion in order to complete the assignment.	On assignments, 60% correlates to a "basic but developing" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	All students successfully complete these labs and most students demonstrate proficiency of all concepts with an average score of 76%.	Students are meeting this outcome.	No action plan.

Principles of Physical Science, PHYS/CHEM 1360 (Fall 2015)

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will explicitly identify attributes of science as compared to non-science, and will identify attributes of scientific practice in their own work.	Quiz 1: "Practices of Science", direct question on how explanations are tested. "Hot Chocolate" lab on developing tests.	"Proficient" understanding rated as 4/5 on rubric scale. Students should demonstrate 4 tests in response to laboratory outcomes	17/18 students were proficient in each measure.	Students are meeting this learning outcome.	No action plan.
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will identify and describe the nature of facts, laws, and theories in scientific work across disciplines. Students will identify attributes of "scientific method" across multiple laboratories that describe scientific work.	Quiz 1: "Practices of Science", direct question on fact, law, and theory. Various lab investigations, especially including "Matter and Energy" investigation that analyzed conservation principles in parallel phenomena.	"Proficient" understanding rated as 4/5 on rubric scale on quiz. "Proficient" understanding at 8/10 on lab report.	17/18 students were proficient in the quiz measure. 15/18 students were proficient in the lab measure.	Students are meeting this learning outcome.	No action plan.
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Students will evaluate and describe relevance of core scientific ideas to their (future) classroom instruction. Students will investigate sources and uses of energy and evaluate the long term implications.	Multiple lab and quiz questions, especially Final Exam essay question to describe "learningful" science. Energy exam question to design electric plant.	"Proficient" understanding rated as 4/5 on rubric scale on quiz/exam.	17/18 students were proficient.	Students are meeting this learning outcome.	No action plan.

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	Students will design investigations, analyze data, and create arguments based on evidence.	All labs and lab reports; most notably final lab and presentation of independent research.	"Proficient" understanding rated as 20/25 on project evaluation.	17/18 students were proficient in the project measure.	Students are meeting this learning outcome.	No action plan.
Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Students will create predictions of physical outcomes based on physical system's conditions and principles.	Multiple laboratory investigations, especially: Newton's laws lab predictions. Astronomy lab predictions and analysis.	"Proficient" understanding at 8/10 on lab report.	18/18 students were proficient in Newton's Laws measure. 15/18 students were proficient in Astronomy measure. (2 lab reports missing.)	Students are meeting this outcome.	No action plan.
Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students must identify and describe basic properties of matter, such as mass, density, charge, etc.	Analysis in Physical Properties of Matter investigation, among others.	"Proficient" understanding at 8/10 on lab report.	18/18 students were proficient in Physical Properties Lab measure.	Students are meeting this outcome.	No action plan.
Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students must determine sources of energy involved in cycling of matter and create designs or make predictions based on conservation of energy.	Energy lab investigation and analysis. Design a power plant exam question.	"Proficient" understanding at 8/10 on lab report. "Proficient" understanding rated as 4/5 on rubric scale on quiz/exam.	15/18 students were proficient in Energy lab measure. 17/18 students were proficient in Energy question measure.	Students are meeting this outcome.	No action plan.
Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students will identify forces creating equilibrium or changes in motion; and they will predict outcome of such forces.	Newton's motion lab analysis. Newton's Laws quiz question on centripetal force and circular motion of marble.	"Proficient" understanding at 8/10 on lab report. "Proficient" understanding rated as 4/5 on rubric scale on quiz/exam.	18/18 students were proficient in lab measure. 15/18 students were proficient in force question measure.	Students are meeting this outcome.	No action plan.

Principles of Physical Science, PHYS 2010 (Johnston, Spring 2016)

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will propose hypotheses, obtain and analyze data, and draw conclusions.	Throughout the course in all its aspects, but directly through laboratory reports and laboratory exam.	"Proficient" demonstration of laboratory tasks, skills, and understandings is at 70%.	46/46 students show proficiency on laboratory reports; 36/46 show proficiency on lab exam.	Students are meeting this learning outcome, although there is an interesting contrast between reports and practical exam.	No urgent action plan, though we are always analyzing the lab program, its exam, and its coherence.

Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will explain and predict motion resulting from balanced and unbalanced forces in varied physical situations.	Quiz 3 and Exam 1: Explicit focus of problems on force problems that demonstrate conceptual understanding and problem solving.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	35/46 students show proficiency on quiz; 37/46 show proficiency on exam.	Students are meeting this learning outcome.	No action plan.
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Students will solve physics problems that have practical, societal impact.	Regular homework problems and in-class exercises. For example, students calculate their own "wattage" and consider the source of their own energy in class.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Students are proficient at homework problem solving overall. On individual tasks like the "wattage" problem, over 90% of students demonstrate proficiency.	Students are meeting this outcome.	But: We need to code more specific exercises to this outcome. Ironically, students are taking this course to further them along towards medical fields, etc. So there's practical import, but we haven't documented all of it.

Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	In Students will collect and analyze data and create arguments based on evidence.	Presentation and analysis of data in lab reports.	"Proficient" demonstration of laboratory tasks, skills, and understandings is at 70%.	46/46 students show proficiency on laboratory reports; 36/46 show proficiency on lab exam.	Students are meeting this learning outcome.	No action plan.
Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Students will create predictions of physical outcomes based on physical system's conditions and principles.	Full-page final exam problem solving that incorporates a sequence of interconnected systems that must be conceptualized together to successfully solve	"Proficient" demonstration of conceptual understanding and problem is at 70%.	33 of 46 students demonstrate full proficiency on this task.	Students are likely meeting this outcome.	We could connect this problem solving to other laboratory tasks or other activities to better understand how students connect these systems.
Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students must identify and describe basic properties of matter and its effect on measures including density, potential energy, momentum, etc.	Explored throughout the course, but explicitly and holistically assessed in conceptual and problem solving problems on Exam 3.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	33 of 46 students demonstrate full proficiency on this task.	Students are meeting this outcome.	No action plan.
Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students must use conservation of energy principles to solve problems, make predictions, and explain phenomena.	Exam 2 holistically and explicitly evaluates students conceptual understanding and problem solving skills in conservation principles.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	28 of 46 students demonstrate full proficiency on this task.	Students are mostly meeting this outcome.	No action plan.
Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students must use analysis of forces to solve problems, make predictions, and explain phenomena.	Explored throughout the course, but explicitly in Exam 1 in which students must explicitly apply Newton's Laws to determine accelerations resulting from forces.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	37 of 46 students demonstrate full proficiency on this task.	Students are meeting this outcome.	No action plan.

Principles of Physical Science, PHYS/ASTR 2040 (Palen, Spring 2016)

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will understand how scientists propose hypotheses, obtain and analyze data, and draw conclusions.	"Astronomical Literature Review" assignment: students read and analyze the work of scientists in the academic literature.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on this assignment was 87.5%, with a majority of students scoring above 80%.	Students are meeting this learning outcome.	No action plan.
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will apply the physics that they have learned for Earth-bound systems to astronomical systems	"Mass of Jupiter" hands-on assignment requires students to apply Newton's Universal Law of Gravitation to observations of the moons of Jupiter, thus deriving the mass of Jupiter from the gravitational acceleration of the moons.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on this assignment was 78.5%, with one student scoring an exceptional 110%, for extending the work beyond that which was required.	Students are meeting this learning outcome.	No action plan.
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Students will make observations and analysis of the night sky and the effect of light pollution on astronomical observations and on the human body.	Light pollution analysis assignment.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on the assignment was 80%.	Students are meeting this learning outcome through this exercise as well as repeated other analyses.	No action plan.

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	Students will collect, analyze, and interpret astronomical data.	Multiple, ongoing laboratories and assignments, especially "Curve Fitting" lab where students understand of fit, chi-square, and P-value is measured.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students achieved an average score of 85% on this assignment, and an 84% on all similar tasks.	Students are meeting this learning outcome.	No action plan.
Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Students will create predictions of physical outcomes based on physical system's conditions and principles.	Multiple laboratory investigations, especially: Hubble Law" lab, where data are interpreted to describe the universe in a hot, dense beginning known as the Big Bang. They then further test this theory in another lab in which they examine the Cosmic Microwave Background Radiation.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students obtained an average of 87.5% on the Hubble Law portion of these paired labs. Due to technical difficulties, the Cosmic Microwave Background portion was incomplete.	Students are meeting this outcome. We've sorted out technical issues with the second portion of the lab and await further data.	No action plan.
Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students will characterize basic properties of matter, such as mass, density, velocity, and angular momentum and a wide range of astronomical scales.	Asteroid Rotation lab: students find the rotation speed of an asteroid from observations of its changing reflectance. Then they calculate out how large the asteroid would have to be in order for this rotation rate to provide sufficient artificial gravity for Earthlings to be comfortable.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students were very interested in this activity, and the lowest score was an 80%. Other similar lab assignments showed varied but still mostly proficient scores.	Students are meeting this outcome.	No action plan.
Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students will predict and explain the conversion of energy from light to electrical current in astronomical research applications.	Analysis of light energy conversion in "CCD Cameras" assignment and in the Cepheid Variable lab.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students produced a bimodal distribution on the CCD Camera assignment, with ¾ of students earning more than 90%, and ¼ of students earning less than 40%.	Students are meeting this outcome.	No action plan.

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
				Discussions with individual students revealed that students who performed poorly were also taking a quantum mechanics final that week. Students performed significantly better on the Cepheid Variable lab, earning an average of 85%.		
Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students will analyze gravitational forces and orbital motions to describe physical properties of an astronomical system (e.g., mass).	Mass of Jupiter lab and the Rotation of Asteroids lab address force concepts most directly by having students analyze motion data to determine force and mass within a system.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students demonstrate proficiency on both labs, as described above.	Students are meeting this outcome.	No action plan.

Principles of Physical Science, PHYS 2210 (Armstrong, Spring 2016)

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will propose hypotheses, obtain and analyze data, and draw conclusions.	Throughout the course in all its aspects, but directly through laboratory reports and laboratory exam.	"Proficient" demonstration of laboratory tasks, skills, and understandings is at 70%.	Lab reports and exams average 80%.	Students are meeting this learning outcome.	No action plan.
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will explain and predict motion resulting from balanced and unbalanced forces in varied physical situations.	Exam 1: Explicit focus of problems on force problems that demonstrate conceptual understanding and problem solving.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Exam score average 78%	Students are meeting this learning outcome.	No action plan.
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Students will solve physics problems that have practical, societal impact.	Regular homework problems.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Students are proficient at homework problem solving overall; but we do not have data parsed out to demonstrate their understandings for these specific problems.	Students are likely meeting this outcome, but …	We need to tabulate and code these specific questions, also possibly adding them to our laboratory assessments.

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Threshold	Findings Linked to Learning Outcomes	Interpretation of Findings	Action Plan/Use of Results
Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	In Students will collect and analyze data and create arguments based on evidence.	Presentation and analysis of data in lab reports.	"Proficient" demonstration of laboratory tasks, skills, and understandings is at 70%.	Lab reports and exams average 80%.	Students are meeting this learning outcome.	No action plan.
Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Students will create predictions of physical outcomes based on physical system's conditions and principles.	Regular homework problems.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Students are proficient at homework problem solving overall; but we do not have data parsed out to demonstrate their understandings for these specific problems.	Students are likely meeting this outcome, but …	We need to tabulate and code these specific questions, also possibly adding them to our laboratory assessments.
Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students must identify and describe basic properties of matter and its affect on measures including density, potential energy, momentum, etc.	Explored throughout the course, but explicitly and holistically assessed in conceptual and problem solving problems on Exam 3 and Exam 4.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Exam score averages were 78%	Students are meeting this outcome.	No action plan.
Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students must use conservation of energy principles to solve problems, make predictions, and explain phenomena.	Exam 3 holistically and explicitly evaluates students conceptual understanding and problem solving skills in conservation principles.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Exam score averages were 76%	Students are meeting this outcome.	No action plan.
Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students must use analysis of forces to solve problems, make predictions, and explain phenomena.	Explored throughout the course, but explicitly in Exam 1 in which students focus on applying Newton's Laws to determine accelerations resulting from forces.	"Proficient" demonstration of conceptual understanding and problem is at 70%.	Exam score average was 78%.	Students are meeting this outcome.	No action plan.

Appendix A

Most departments or programs receive a number of recommendations from their Five-Year Program Review processes. This page provides a means of updating progress towards the recommendations the department/program is acting upon.

We have made several changes, and continued several practices, in response to our program review. These include: keeping in contact with both alumni and regional stakeholders, updating our teaching practices, and hiring a new tenure track faculty member in the area of Materials Science.

Appendix B

Please provide the following information about the full-time and adjunct faculty contracted by your department during the last academic year (summer through spring). Gathering this information each year will help with the headcount reporting that must be done for the final Five Year Program Review document that is shared with the State Board of Regents.

Faculty 2015-16	
Headcount	19
With Doctoral Degrees (Including MFA and other terminal degrees, as specified by the institution)	13
Full-time Tenured	7
Full-time Non-Tenured (includes tenure-track)	1
Part-time and adjunct	5
With Master's Degrees	
Full-time Tenured	
Full-time Non-Tenured	1
Part-time and adjunct	5
With Bachelor's Degrees	
Full-time Tenured	
Full-time Non-tenured	
Part-time and adjunct	
Other	
Full-time Tenured	
Full-time Non-tenured	
Part-time	
Total Headcount Faculty	19
Full-time Tenured	7
Full-time Non-tenured	2
Part-time	10

Please respond to the following questions.

1) Based on your program's assessment findings, what subsequent action will your program take?

   Our assessment focus will be shifting toward courses within our major after completion of the major effort on General Education (PS) course renewal.

2) We are interested in better understanding how departments/programs assess their graduating seniors. Please provide a short narrative describing the practices/curriculum in place for your department/program. Please include both direct and indirect measures employed.

   We are pleased with the strategy we have for general education assessment – emphasizing two outcomes at a time and working with one another to both reflect upon what these really mean as well as how we measure them. We also think that there's a rich collection of information in our capstone project (PHYS 4990) and exit interviews and surveys that we have yet to fully document. We continue to work on ways of keeping in contact with graduates during their next steps following graduation and would be open to any advice on that.