Physics Program

Pepperdine University

Jul 18, 2016

Pepperdine University Program Review

Physics Program

INTRODUCTION

1. INTERNAL CONTENT
a. The Physics Program at Pepperdine University is located in the Natural Science Department at the Seaver College campus. Physics is one of several majors offered in the Natural Science Department: 3/2-Engineering, Biology, Chemistry, Computer Science/Mathematics, Mathematics, Nutritional Sciences, and Sports Medicine. It is the cornerstone of any science department, most majors require at least one semester of physics. At one time Physics was called Natural Philosophy because it is the foundation for all or the natural sciences. Physics provides important required courses for the Liberal Arts major. These same courses also fulfill the General Education lab requirement for Seaver College's undergraduate students.

b. The Physics Program offers a Bachelor of Science (Physics B.S.) degree and Physics minor. A degree in Physics prepares the student for graduate work in Physics, Geophysics, Chemical Physics or Engineering. The Physics major provides a sufficient base for the student to competitively enter the work force as a physicist or scientist in industry in addition to working as an engineer. The physics graduate can also find employment as middle or high school physics teacher.
The Liberal Arts major requires the students to take a laboratory course in the physical sciences. The Physics curriculum offers three Natural Science (NASC): NASC 155, NASC 156, or NASC 109. NASC 155 is a course which covers classical through modern physics and chemistry. NASC 156 covers the physical sciences Geology, Meteorology, Oceanography, and Astronomy. NASC 109 is an introduction to astronomy. The Liberal Arts degree requires two of these three courses. These three courses can also be used to fulfill the undergraduate general education lab requirement.

c. The Physics Program is located at Seaver College in Malibu, California.

d. Provide a brief history of the program.

The Physics major was originally part of the curriculum at Pepperdine University but was dropped at a later date. Dr. William Phillips chaired a committee to revive the Physics major during the 2004 Fall semester which was later approved by SAC to begin in the 2005 Fall semester. In the 2005/2006 academic year, the Physics program began offering classes. The physics minor was added in 2008/2009 academic year. In 2008 the Physics Program had its first graduate, Don Mitchell. The next graduating class, 2009, had three graduates. In 2015 Pepperdine University granted 9 B.S. degrees in physics. We have sent many of our first graduates off to masters and Ph.D. programs, including those at Stanford and Rensselaer Polytechnic Institute. Don Mitchell, our first physics graduate, graduated from Loyola Marymount University in 2010 with an M.S. degree in Mechanical Engineering. He is currently employed by Southwestern Industries, Inc.

e. Describe the changes made to the program since the last review.

Several changes have occurred since the last review for the physics program:
(i) Undergraduate research programs have been implemented with an emphasis on recruiting first year students. This has helped prepare the students for summer internships at NASA and REU's throughout the country. The research has enabled the students to travel to conferences, five annual American Geophysical Union (AGU) meetings, where they present results of their research.

(ii) Three new courses have been added to increase the depth of the physics curriculum. Physics 240 is an introduction to numerical programming and emphasizes basic numerical and computational methods, Physics 421 is a course in condensed matter which investigates both classical and quantum models for the behavior of electrons and lattice vibrations in bound matter, and Physics 425 is an introductory course in General Relativity which explores Riemannian geometry and the Einstein field equations.

(iii) Physics 330 had the name changed from Intermediate Mechanics to Classical Mechanics. Physics 380 (modern physics lab) was changed from a 2 to 3 unit course in order to broaden the scope of and number of experiments for the course.

(iv) The physics minor has been changed to allow the students more flexibility. The required courses for the physics minor are Physics 210 (one-semester calculus based course in Newtonian physics), Physics 211(one-semester calculus based course in electromagnetism, electromagnetic waves, physical and geometrical optics), Physics 312 (modern physics), and Physics 320 (mathematical methods of physics). The student then must choose of the following courses: Physics 330 (classical physics), Physics 380 (modern physics lab), Physics 410 (electricity and magnetism I), Physics 411 (electricity and magnetism 2), Physics 420 (electronics), Physics 421 (condensed matter), Physics 425 (General Relativity), Physics 430 (thermodynamics and statistical mechanics), and Physics 440 (quantum mechanics). This change allows the student to choose a minor with an emphasis on theory or experimental physics.

(v) Two new tenure track faculty have been hired, Dr. John Mann and Dr. Gerard Fasel, and a visiting lecturer (Mary Holden) was also hired. Dr. Mann is an experimentalist in material science and has started an experimental program for undergraduates. Dr. Fasel is a theorist working on Solar-Terrestrial interactions. He has implemented an undergraduate research program in Space Physics which uses satellite data from NASA and ground-based optical data from the Kjell Henriksen Observatory in Longyearbyen, Norway.

2. THE EXTERNAL CONTEXT
This should explain how the program responds to the needs of the area in which it serves: this can include the community, region, field, or discipline.

The Physics Program at Pepperdine University is beginning to make its presence known in the Space Physics Community. Dr. Gerard Fasel has been a convener/chair for four sessions (2012-2015) at the annual Fall American Geophysical Union (AGU) conference which is held in San Francisco at the Moscone Center [Dayside Transients (AGU 2012); Solar Wind Influence on Dayside Transients (AGU 2013); Solar-Terrestrial Interactions: Dayside Transients in the High-Latitude Ionosphere and Magnetosphere (AGU 2014); Magnetospheric Response to Transient Solar Wind Phenomena (AGU 2015)]. This is one of the largest scientific conferences in the world. Dr. Fasel has taken students to this meeting for the past five years. This past conference, 2015 December, Dr. Fasel took 13 students to the AGU meeting in San Francisco. The students have presented the results of their research at these meetings. This has exposed the students to the scientific process of planning a research project, collecting and analyzing data from the study,

and organizing the results for a professional meeting.
Dr. Fasel is currently collaborating with Dr. Lou-Chuang Lee, (current Director of Institute of Earth Sciences at Academia Sinica; Taiwan National Science Council, Minister, 2008-2012), Dr. Fred Sigernes (Head Scientist of the Kjell Henriksen Observatory, Longyearbyen, Norway), and Dr. David Sibeck (NASA, Goddard Space Flight Center; current Space Physics and Aeronomy SPA section president).
With the help of Dr. David Sibeck, Dr. Fasel has placed three Pepperdine student in NASA summer internships during the past few years. Currently he is working with Dr. Sibeck, funding permitting, to obtain two NASA 2016 summer internships.
Our faculty has active memberships in several professional societies. Dr. Fasel is a member of AGU-Space Physics and American Association of Physics Teachers.
Dr. Mann is a member of the American Physical Society.

PROGRAM OUTCOMES

Institutional Learning Outcomes

Identifier	Description
CA-PEP-ILO-15.L-1-KS	Think critically and creatively, communicate clearly, and act with integrity.
CA-PEP-ILO-15.L-2-FH	Practice responsible conduct and allow decisions and directions to be informed by a value-centered life.
CA-PEP-ILO-15.L-3-CGU	Use global and local leadership opportunities in pursuit of justice.
CA-PEP-ILO-15.P-1-KS	Demonstrate expertise in an academic or professional discipline, display proficiency in the discipline, and engage in the process of academic discovery
CA-PEP-ILO-15.P-2-FH	Appreciate the complex relationship between faith, learning, and practice.
CA-PEP-ILO-15.P-3-CGU	Develop and enact a compelling personal and professional vision that values diversity
CA-PEP-ILO-15.S-1-KS	Apply knowledge to real-world challenges.
CA-PEP-ILO-15.S-2-FH	Respond to the call to serve others.
CA-PEP-ILO-15.S-3-CGU	Demonstrate commitment to service and civic engagement.

Additional Standards/Outcomes

Identifier	Description
CA-PEP-SVR-15.BSPHYSICS-1	Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.
CA-PEP-SVR-15.BSPHYSICS-2	Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.
CA-PEP-SVR-15.BSPHYSICS-3	Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.

CA-PEP-SVR-15.BSPHYSICS-4	Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.

CURRICULUM MAP

MISSION, PURPOSES, GOALS, AND OUTCOMES

a) Mission

At one time Physics was called Natural Philosophy and an understanding of physics is essential in research in all other scientific disciplines today. The mission of the Physics Program at Pepperdine University is to provide the students with a set of tools they can use in pursing their careers in the physical or life sciences. Some career paths may require graduate programs in physics, chemistry, engineering, or possibly law or medical school. Liberal Arts and general education students are also in need of the instruction provided by the Physics Program. The physics curriculum integrates theoretical concepts along with experimental techniques that enable the student to obtain a deeper understanding of Nature. Typical classroom lectures are complemented with laboratory experiments where the student can experience the discovery process. Theoretical topics covered are Classical Physics, Electromagnetism, Thermodynamics and Statistical Mechanics, and Modern Physics (Including Special Relativity, Quantum Mechanics, etc.). Lower division laboratory courses include experiments that explore Classical/Newtonian concepts, Electromagnetism, and Thermodynamics. The upper division labs are more complex and are associated with modern physics topics, e.g. Photoelectric effect and quantum dots. The combination of theory and experiment provide a base for students to gain an understanding of the fundamental properties of Nature.

Creativity and critical thinking are important tools which are needed when trying to combine theoretical ideas and experimental techniques. To develop these tools student research projects are encouraged and are guided by professors. These projects allow the students to explore and discover the scientific method. This is accomplished by making observations, asking questions, and developing a model to explain the observations. Observations of natural processes are important for a physicist; this provides the basis for finding a problem to study or explore. Developing questions regarding the observations is an important next step to obtaining an understanding of the phenomena being studied. A fundamental understanding of the core principles of physics are needed to develop a model or experiment that explains or replicates the observation being analyzed.
The professors of the Physics Program are committed to upholding the Mission of Pepperdine University and Seaver College. They strive for developing students with a strong base of knowledge both academically and spiritually so that when the student leaves Pepperdine University she or he is prepared for a career and life of purpose, leadership, and service which will benefit humanity.

b) Goals
The Goals for the Physics Program are:
1) Prepare the physics student so that she or he attains a fundamental understanding of Nature by acquiring knowledge via studies in Classical Physics, Electromagnetism, Thermodynamics and Statistical Physics, Modern Physics (including Special Relativity, Quantum Mechanics, etc. …).

2) Prepare the physics student so that she or he develops critical thinking skills via professor guided research programs.
3) Expose the physics student to the diverse number of careers that are available after graduation by attending conferences which have career booths and grad school advisors.
4) Prepare the physics student for a life of service, leadership, and spiritual commitment.

c) Outcomes
The learning outcomes identified by the Physics Program are:
1) Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics:
PHYS 210/211/240/312/320/330/410/411/421/425/430/440
2) Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena:
PHYS 210/211/380/420/490
3) Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms:
PHYS 201/210/211/240/312/320/330/380/410/411/420/421/425/430/440/490
4) Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities:
PHYS 490

I - Introduced
D - Developed
M - Mastered

Physics Curriculum Map

	PHYS 201	**PHYS 202**	**PHYS 203**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.	I	I	I
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.	I	I	I
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.		I	I
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.		I, D	I, D

	PHYS 210	**PHYS 211**	**PHYS 240**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.	I	I	

CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.		I	D
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.	I	I	
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.			

	PHYS 292	**PHYS 299**	**PHYS 312**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.			I
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.			
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.			
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.			

	PHYS 320	**PHYS 330**	**PHYS 380**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.		D	
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.	D		M
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.			D
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.			

	PHYS 410	**PHYS 411**	**PHYS 420**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.	D	D	
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.			D
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.			D
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.			

	PHYS 421	**PHYS 425**	**PHYS 430**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.	D	D	D
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.	D		
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.	D	D	
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.			

	PHYS 440	**PHYS 490**	**PHYS 492**
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.	M		
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.			
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.			

CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.			

	PHYS 499
CA-PEP-SVR-15.BSPHYSICS-1 Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.	
CA-PEP-SVR-15.BSPHYSICS-2 Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.	
CA-PEP-SVR-15.BSPHYSICS-3 Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.	
CA-PEP-SVR-15.BSPHYSICS-4 Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.	

ANALYSIS OF EVIDENCE: Meaning

Meaning

The Physics Program's learning outcomes are in line with the Mission of Pepperdine University and the established learning outcomes of Seaver College. The curriculum and learning outcomes in the Physics Program support the following learning outcomes of Seaver College:
1) Think critically and creatively, communicate clearly, and act with integrity,
2) Practice responsible conduct and allow decisions and directions to be informed by a value-centered life,
3) Use global and local leadership opportunities in pursuit of justice,
4) Demonstrate expertise in an academic or professional discipline, display proficiency in the discipline, and engage in the process of academic discovery,
5) Appreciate the complex relationship between faith, learning, and practice,
6) Develop and enact a compelling personal and professional vision that values diversity,
7) Apply knowledge to real-world challenges,
8) Respond to the call to serve others,
9) Demonstrate commitment to service and civic engagement.

The learning outcomes for the Physics Program are:
1) Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics.
2) Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena.
3) Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms.
4) Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.

How does the degree embody the distinct values, basic commitment, and traditions of the institution?

The Physics Program supports the Mission of both Pepperdine University (Pepperdine is a Christian university committed to the highest standards of academic excellence and Christian values, where students are strengthened for lives of purpose, service, and leadership.) and Seaver College (Seaver College exists to provide a link between the knowledge and wisdom of the past and present with the challenges of the future). The integration of faith and learning is the cornerstone of the Physics Program. The study of nature is the basic goal of any Physics Program. Physicists spend much of their lives trying to understand the basic components of Nature. In doing so they ultimately realize the complexity and beauty of the Universe that we reside indicates that it must have a grand creator. The world-wide discussion of Science and Faith, which has been carried on in numerous Physics courses during the last few years, has been advanced primarily by Physicists and the discussions continually appeal to the fundamental laws of Physics. The faculty in the Physics Program has a deep faith and believes that it is healthy spiritually to have an open dialogue with the physics students regarding faith and learning. Incorporating a discussion about God is an important aspect when discussing Cosmology (the study of the origin of our universe). Students are encouraged to discuss how their faith intertwines with the material they are learning.

Is there a coherent, aligned sequence of learning opportunities?

The Physics Program has a coherent, aligned sequence of learning opportunities via the Physics curriculum which is aligned with the program learning outcomes:
Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics:
PHYS 210/211/240/312/320/330/410/411/421/425/430/440
Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena:
PHYS 210/211/380/420/490
Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms:
PHYS 201/210/211/240/312/320/330/380/410/411/420/421/425/430/440/490
Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities:
PHYS 490
The lower division courses PHYS 210 and PHYS 211 provide a base knowledge for the following upper division courses, PHYS 312, PHYS 330, PHYS 380, PHYS 410, PHYS 411, PHYS 420 and PHYS 430. PHYS 210 and PHYS 211 expose the students to new and fundamental terminology, principles, and laws needed to grasp the basic concepts in physics. In addition PHYS 312 provides a deeper insight for PHYS 380, PHYS 421, PHYS 425, PHYS 430 and PHYS 440. The PHYS 312 course exposes the students to modern physics and its concepts. The course covers a multitude of topics including Special Relativity, Photoelectric effect, Compton Effect, Blackbody radiation, de Broglie wavelength, Heisenberg Uncertainty Principle, Quantum Mechanics, Nuclear Physics, Particle Physics, and Solid State Physics. PHYS 312 also provides the background and theory for the experiments that are executed in PHYS 380. Phys 320 provides the mathematical background needed for successful completion of PHYS 330, PHYS 425, and PHYS 440.

Does the degree offer sufficient breadth and depth of learning for this particular major or program? Please explain.

The Physics Program does offer sufficient breadth and depth in its curriculum. The physics student starts out taking PHYS 210 and PHYS 211. Both PHYS 210 and PHYS 211 are engineering/scientist calculus based physics courses. PHYS 210 covers classical physics, including vectors, translational kinematics, rotational kinematics, rotational dynamics, equilibrium of rigid bodies, work, energy, momentum and collisions, gravity, fluids (statics and dynamics), pressure, vibrations, waves, kinetic theory, heat, the first and second law of thermodynamics. PHYS 211 covers electrostatics (electric field, Gauss' Law, electric potential, capacitors and dielectrics), currents and resistors, inductance and alternating currents, magnetostatics (Ampere's Law, Faraday's Law), electromagnetic waves, geometrical and physical optics.

Both PHYS 210 and PHYS 211 provide the necessary background for PHYS 312 (modern physics). PHYS 312 is taken after PHYS 210 and PHYS 211. PHYS 312 covers the following topics: Special Relativity, blackbody radiation, Compton effect, Photoelectric effect, Bragg Scattering, x-ray production, introductory quantum mechanics, nuclear and particle physics.

The combination of PHYS 210, PHYS 211, and PHYS 312 provide the physics student a breadth of fundamental physics topics.

PHYS 320 (mathematical methods of physics) provides the mathematical background needed for the upper division physics courses. Topics include vector analysis, linear algebra, Fourier analysis, and differential equations.

The physics students are now prepared to take their upper division physics courses, PHYS 380 (experimental physics), PHYS 410 (electrostatics and magnetostatics, electric and magnetic fields in materials), PHYS 411 (Faraday's Law, electromagnetic waves, radiation, Special Relativity), PHYS 420 (electronics), PHYS 421 (condensed matter), PHYS 425 (introduction to general relativity theory), PHYS 430 (thermal and statistical physics), and PHYS 440 (quantum mechanics). These courses are designed to allow the physics student to obtain a deeper fundamental understanding of the wide range of topics studied in PHYS 210, PHYS 211, and PHYS 312.

PHYS 240 (numerical methods) provides the physics student with an introduction to C++ and develops numerical and computational skills which can be used for upper divisional courses. PHYS 380 is a laboratory course in which the students carry out the actual experiments they studied in PHYS 211 and PHYS 312 (e.g. Hall effect, Photoelectric effect, Band gap dependence on particle size (quantum dots)). PHYS 420 is a lecture laboratory course. Circuits and their components are discussed in detail and then built by the students. PHYS 490 is a research based course where the physics student works under the guidance of a professor on a research topic. The theory and skills developed in the lower and upper division courses provide a base of knowledge and understanding of
core physics principle, which allow the physics student to be successful in research.

A typical four year plan for the Physics Program would have the physics student take PHYS 210 and PHYS 211 in their first year. In second year the physics student would take PHYS 240, PHYS 312, PHYS 320, and PHYS 380. The remainder of the physic courses would be taken during the third and fourth year of the physics student undergraduate career. This sequence allows the physics student to obtain both breadth and depth in their study of physics at Pepperdine University.

Please present a curriculum comparison with at least three peer institutions and with national disciplinary or professional standards if available.

PHYSICS

Comparison of Physics (B.S.) curriculum or equivalent program across peer institutions.

Institutions	Units Required for Degree	Chemistry	Calculus	Modern Physics	Classical Mechanics	Electricity and Magnetism	Upper Division	180 Courses	# Faculty	Other
Pepperdine University	18/70	2/4	3/12	1/3	1/3	2/6	9/29	4	4	
Loyola Marymount University	26/78	2/4	3/12	2/7	2/7	4/13	13/45	6	7	
University of San Diego	21-22/66	2/8	3/12	2/6	1/3	1/3	13-14/34	6	6	B.A.
Westmont College	21-22/67-68	2/8	3/12	2/5	1/4	1/4	10-11/32-33	5	5	

Listed as number of courses/number of units

The Physics Program at Pepperdine University compares quite well with similar institutions: Loyola Marymount University, University of San Diego, and Westmont College. The number of courses is comparable: 18 Courses required for Pepperdine University, 26 for Loyola Marymount University, and 21-22 for University of San Diego and Westmont College. Foundation courses in chemistry and calculus are nearly identical. The modern physics component is one course lower than the other four peer institutions. For classical mechanics, only Loyola Marymount University has two required courses. Electricity and magnetism is a two course requirement at Pepperdine University, while University of San Diego and Westmont College require only one course. Only Loyola Marymount University requires four courses in electricity and magnetism. The Physics Program at Pepperdine University offers a course in General Relativity and Numerical Programming, neither course is offered at the other institutions. The core courses required by peer institutions are the same as those offered in Pepperdine's Physics Program: Classical Physics, Electricity and Magnetism, Thermodynamics and Statistical Mechanics, Mathematical Methods of Physics, and Quantum Mechanics. Pepperdine University and Westmont College have the fewest faculty members, four and five respectively. Both Loyola Marymount University and University of San Diego have six faculty members.

How current is the program curriculum?

The Physics Program is at Pepperdine University is currently up to date regarding course content and laboratory experiments. Textbooks for the curriculum are constantly updated. Faculty members search for updated versions of the textbooks currently used and look for new material that can be used to upgrade the lectures. Laboratory experiments are refined each semester and new equipment is purchased on a yearly basis. Seaver College provides funding for major equipment purchases each year. Within the last two years the modern physics lab recently purchased items to upgrade its labs:
Thor Labs Vis spectrometer
Keithly 2450 source meter
Stanford research systems lock in amplifier
Type II superconductors in 4 wire configuration

n type and p type germanium crystal for Hall Effect

PHYS 420 is a lecture/lab course. Equipment was purchased to upgrade the electronics lab section of the course. The following items were recently purchased for PHYS 420:
Power Supplies
Breadboards
Connecting Wires
Resistors
Microphones
Trimpots

The physics faculty meets often during the academic school year to discuss the curriculum for the Physics Program and any new information that may be important to enhance the lectures or laboratory procedures. Dr. Mann, in his second year, was hired to enhance the experimental aspect of the Physics Program. His current research involves developing and applying known techniques for synthesizing and creating novel layered structures out of Van der Waals 2-D materials. His current project is developing an inexpensive, facile technique for synthesizing monolayer〖 MoTe〗_2 on a SiO_2/Si substrate with the intention of creating stacks of heterojunctions with monolayer MoS_2. Dr. Mann recently purchased major equipment in the last year to support his current research projects. Equipment purchased:

Horiba Lab Ram HR800 (Raman spectrometer)
AFM Workshop NP-AFM (Atomic Force Microscope)
1200°C Compact Split Tube Furnace with Vacuum Flanges with mass flow controllers
Nikon TE2000-U E Inverted Motorized Fluorescent Microscope

Dr. Fasel's research examines Solar-Terrestrial coupling. Data is obtained from NASA (satellite data) and from the Kjell Henriksen Observatory (ground based data) in Longyearbyen, Norway. Student research projects have resulted in five poster presentations at the annual American Geophysical Union (AGU) held in San Francisco, California.

How has the curriculum changed (if at all) over the last five years including the reasons for the change (e.g., the result of a learning outcome assessment) and evidence used as a basis for change?

The Physics Program has changed in several ways since the last five-year review. First the Physics faculty has increased in size. The past five-year review suggested the hiring of new physics faculty (tenure track positions). There are now four full time professors, three new tenure track faculty (Ken Henisey, John Mann, and Gerard Fasel) and one visiting lecturer (Mary Holden). The addition of the new tenure track faculty has created new physics research programs. Dr. John Mann has created an experimental physics research program At Pepperdine University. His current research involves developing and applying known techniques for synthesizing and creating novel layered structures out of Van der Waals 2-D materials.

Dr. Gerard Fasel has created an undergraduate space physics research program. His studies examine the Solar-Terrestrial coupling process. In particular Dr. Fasel looks at magnetic reconnection which occurs at the subsolar point of the magnetopause. The student driven research has led to five poster presentations at the American Geophysical Union (AGU) meeting in San Francisco. In December 2015, thirteen students attended the AGU meeting with Dr. Fasel. Seven students attended the AGU conference in 2014.

Dr. Ken Henisey's current research interests look at the biomechanics of weightlifting.

The visiting lecturer position is a non-research position because of the required large course load. Mary Holden has been extremely successful in teaching the PHYS 202 and PHYS 203 courses. Her experience and passion for teaching has made her very successful and popular with the students. Her office on any given afternoon is filled with several students. Mary is the first female on the physics faculty.

The Physics Program has made several curriculum changes in the past five years. The addition of three new courses has strengthened the program. PHYS 240 is a numerical methods course. This provides the physics student with an introduction to C++ and develops numerical and computational skills which can be used for upper divisional courses. PHYS 421 (condensed matter) and PHYS 425 (General Relativity) provide extra depth for the upper division curriculum. PHYS 380 was changed from a two to three unit laboratory course. The extra unit provides time for extra instruction and experiments.

The last five year review for the Physics Program stated that the labs needed to be updated. Several new pieces of equipment were purchased for PHYS 380 (modern physics lab) to modernize the course. The following is the list of equipment purchased for PHYS 380:

Thor Labs Vis spectrometer
Keithly 2450 source meter
Stanford research systems lock in amplifier
Type II superconductors in 4 wire configuration
n type and p type germanium crystal for Hall Effect

Pedagogy: Please present measures of teaching effectiveness (e.g., course evaluations, peer evaluations of teaching or implementing, scholarship on issues of teaching and learning, formative discussions of pedagogy among faculty, survey measures, participation rates, and student satisfaction surveys).

Teaching
Student Evaluations

	Enrollment	Course GPA	Professor Score	Course Score
Mean	22.9	2.89	4.22	3.99
St. Deviation	14.3	0.34	0.37	0.37
Minimum (0%)	4.0	2.33	3.18	3.10
Quartile 1 (25%)	13.0	2.63	3.99	3.88
Median (50%)	18.5	2.90	4.29	4.10
Quartile 3 (75%)	25.8	3.11	4.44	4.24
Maximum (100%)	51.0	3.67	4.79	4.49

Every semester each course in the Physics program has a student evaluation. The evaluations are submitted online by the students. The students have a ten day window to fill out the course evaluations, the last day being the day before final examinations begin. These evaluations have a

course and professor component.

The physics faculty has an incessant dialogue throughout the semester regarding pedagogical issues. We discuss the homework and exams that we give throughout semester in our courses. The dialogue between physics faculty members produces constructive criticism which helps each professor enhance their teaching. Students are asked throughout the semester for feedback regarding the course. The students are willing to give insight to the things that are helpful and those that could be improved.

At the end of every semester each Natural Science faculty member is asked to fill out an evaluation sent out by the divisional dean. These evaluations ask for the professor to outline their teaching and research responsibilities during the past academic year. For the teaching component, the faculty members are required to give a detailed description on their teaching methods and asked how they plan to improve methodology in the upcoming school year. The divisional dean prepares an annual report which includes the teaching evaluations for each faculty member. Comments from the divisional dean incorporate both the weak and strong points from the student evaluations and also includes suggestions on how to improve the weak areas.

ANALYSIS OF EVIDENCE: Quality

Quality

a) SERVICE LEARNING
The Physics Program provides a couple of opportunities for the students to reach out to the community by providing mentoring to pre-college students. Pepperdine is a member of the Society of American Military Engineers (SAME) and is sponsored by the Naval Base of Ventura County. Every summer the Naval Base brings middle and high school students to the base for a week of learning. Pepperdine students are asked to volunteer to help mentor these pre-college students, helping these kids with engineering projects, building bridges, etc. … . Every spring there is a science fair at a local Malibu school where Pepperdine physics students discuss science with the general public. They help design and build an exhibit that demonstrates a principle in physics.
b) RESEARCH OPPORTUNITIES
The Physics Program has two summer research opportunities with Dr. Mann and Dr. Fasel. Dr. Mann's current research involves developing and applying known techniques for synthesizing and creating novel layered structures out of Van der Waals 2-D materials. His current project is developing an inexpensive, facile technique for synthesizing monolayer 〖MoTe〗_2 on a SiO_2/Si substrate with the intention of creating stacks of heterojunctions with monolayer MoS_2. Last summer Dr. Mann led two students through a summer research internship. He is planning on doing the same this summer.
Dr. Fasel's research interest is the coupling between the solar wind and the Earth's Magnetosphere. Energy and momentum are imparted from the solar wind into the Earth's Magnetosphere. The primary mechanism for this coupling is magnetic reconnection. He research looks for ionospheric signatures of magnetic reconnection. Satellite data from NASA is combined with the ionospheric observations to obtain a better understanding of this process. Over the past three summers Dr. Fasel has had several students work with him on a research project. Each project has led to a presentation by the students at the annual American Geophysical Union (AGU) meeting.
c) INTERNSHIPS
Dr. Fasel has placed three students (Richard Aylward, Alexandra Angelo, and Sarah Bender) in a NASA summer research program. With the help of Dr. Sibeck from NASA Goddard, the students

are introduced to a problem and are led through research project by NASA scientists as mentors. Two of these summer internships led to presentations at the annual Fall American Geophysical Union meeting:
NASA Internships that were presented at the AGU conference (Space Physics)
Dec. 2014 “Foreshocks significance in Generation of ULF Waves’’, Alex Angelo, Olga Gutynska, David Sibeck. (poster)
Dec. 2014 “Morphology and Dynamics of Auroral Arcs’’, Sarah Bender, Kyle Murphy, David Sibeck. (poster)
Funding permitting, Ashley Rothballer and Taylor Brandt will be heading to NASA Goddard for a summer 2016 internship.
d) HIGH-IMPACT PRACTICES
Students that are working with Dr. Mann or Dr. Fasel are required to read papers from the literature to enhance their understanding of the particular field in which they are doing research. Weekly meetings are held to review data collected during the past week and discuss any issues that manifested during research. Each student is asked to give a small presentation on their accomplishments during the past week. When presentations are being prepared for conferences the students are asked to participate in the writing and organization of the material that will be presented. Before each conference there is a practice session where each student is required to give a presentation of the paper being presented.

Co-Curricular : How intentional are the co-curricular experiences which are provided and how are they integrated into the curricular plan?

a) Academic and career advising programs and resources:
At the beginning of each school year there is a New Student Orientation (NSO) which occurs the week before classes begin. During this week the new students are advised and helped to construct their course schedule for their first semester at Pepperdine University. Faculty members from the Physics department help with placing the students in the proper classes they need in their first semester. The students are given a campus tour which acquaints the students with the location of One-stop (students are given an advisor from one-stop, course changes occur here throughout the academic year), the financial aid office, the counseling center (this is important for students that have disabilities including learning, Health Services, the library and its services, the gym facilities, and dorm accommodations. The students are given a first year seminar advisor (usually from another discipline). There are informal sessions that discuss the international programs, Greek and Spiritual Life on campus. During the week there is also an academic majors fair where a professor from each discipline is present to answer any questions first year or transfer student may have regarding courses. The students also meet with their resident assistant (RA). The RA’s help out with any housing issue that may arise for the new student. Every new student is placed in a first year seminar which helps the student make the transition to academic life at Pepperdine University.
The career center provides help for the student that is assembling a resume or curriculum vitae. The Student Employment Center is able to provide guidance for students wishing to secure employment on campus. During the academic year there are career fairs which provide a forum where students can meet and talk with prospective employers.
b) Tutoring, supplemental instruction, and teaching assistants:
Tutoring is available for every discipline. Tutors are chosen by the faculty members and are usually available for a number of hours during the week. Each class generally has a teaching assistant (TA) that helps the professor with grading homework, laboratory reports, and mentoring students. The TA’s are usually upper class students which have successfully passed the course they are TA’ing.
c) Orientation and transition programs:
The New Student Orientation and First year seminar are programs which orient the new student and help each student with the transition into academic life at the university. This is discussed in

more detail in part (a).
d) Financial support for obtaining scholarships, fellowships, teaching assistantships, etc.:
The Natural Science department has a yearly scholarship, between $130000-$150000. Students apply for the scholarship and their applications are evaluated by the divisional dean and program coordinators. Awards are based on academic achievement. Student jobs (tutors, teaching assistants, research assistants) are funded by the Natural Science department. An average of $72000 is awarded to the Natural science department each year for student salaries. These jobs are extremely beneficial for the students. They allow the student to reinforce concepts they originally learned in the classroom, build mentoring skills, and provide an opportunity to begin compiling their resumes and CV's. This is important when the student graduates and begins looking for employment.
e) Support for engagement in the campus community:
There are many opportunities for the student to become involved in the campus community: Dance in Flight (a dance group in which the students must audition, performances are held in the spring semester after rehearsal during the fall semester), Song Fest (student and faculty get together to develop and perform musical pieces during the spring semester), Greek Life, Club convos (designed by both students and professors to fulfill the spiritual and secular needs of the students), Veritas club (another opportunity to discuss the interaction of faith and the secular world),
f) Support for emotional and psychological variables of success:
The counseling center is responsible for supporting the emotional and psychological needs of the students. For example, learning disabilities can lead to failure at the university level. The counseling center provides numerous methods which can help the student with any type of learning disability. The staff is well trained to deal with most emotional and psychological problems that may plague the students.
g) Spiritual development programs and opportunities:
Club Convo and the Veritas club are two opportunities for the student to enhance their spiritual development. Please see (e) for more detail.
h) Multicultural opportunities which support diversity:
Pepperdine supports diversity. The international student office is responsible for supporting the international student population. There are many different clubs on campus, e.g. Hawaiian club, Korean Club, Armenian Club. Club convo also supports diversity and multicultural options.
i) Plays, musicals, art exhibits, and lectures:
There are several plays throughout the academic year. Dance in Flight and Song Fest occur in the spring semester. The Weisman Museum has several exhibits throughout the year. The Dean's lecture is a great opportunity for the students see lectures by influential leaders from many different fields.
j) The Sophomore Experience:
There is a sophomore trip that every second year student is encouraged to participate in during the spring semester. This spring, 2016, the students headed to San Francisco for a weekend of fun.
k) Study Abroad:
Physics majors and minors, as are all other Seaver College students, are encouraged to spend at least one semester studying overseas in one of Pepperdine's International Programs. While courses that specifically satisfy Physics major or minor requirements are not usually taught in the International Programs, a great number of the GE courses are and, by prior careful advance planning with his or her major professor, a Physics student can study abroad without delaying the student's progress toward graduation by taking a number of the GE courses overseas and the Physics courses in Malibu. In exceptional circumstances, students with foreign language capabilities have been able to take major-equivalent courses at foreign universities.

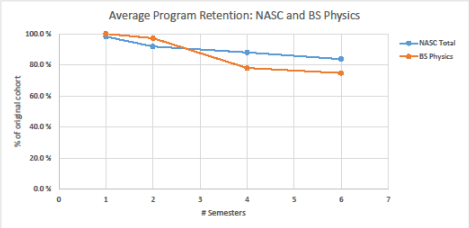
What is the profile of students in the program and how does the profile relate to or enhance the purpose and goals of the program?

Program Review Data Report
School: Seaver College
Division: Natural Science -Physics
Date: March 6th, 2015.

SAT SCORE AND GPA BY MAJOR AND MINOR

ENROLL TERM	Fall 2010 (Term:2106)			Fall 2011 (Term:2116)			Fall 2012 (Term:2126)			Fall 2013 (Term:2136)			Fall 2014 (Term:2146)		
Seaver - Natural Science	AVG SAT READ	AVG SAT MATH	AVG HIGH SCHOOL GPA	AVG SAT READ	AVG SAT MATH	AVG HIGH SCHOOL GPA	AVG SAT READ	AVG SAT MATH	AVG HIGH SCHOOL GPA	AVG SAT READ	AVG SAT MATH	AVG HIGH SCHOOL GPA	AVG SAT READ	AVG SAT MATH	AVG HIGH SCHOOL GPA
Major	**640**	**714**	**3.80**	**629**	**705**	**3.81**	**599**	**698**	**3.65**	**629**	**692**	**3.60**	**635**	**672**	**3.68**
BSPHYSICS Physics	640	714	3.80	629	705	3.81	599	698	3.65	629	692	3.60	635	672	3.68
Minor				**620**	**720**	**4.00**	**510**	**640**	**3.80**	**510**	**640**	**3.80**			
MNPHYSICS Physics				620	720	4.00	510	640	3.80	510	640	3.80			
Grand Total (Major & Minor - AVERAGE SCORE)	**640**	**714**	**3.80**	**628**	**706**	**3.82**	**593**	**694**	**3.66**	**624**	**689**	**3.61**	**635**	**672**	**3.68**

Note: Students with double majors/minors are counted more than once.



Term	NASC Division	Cohort	One Semester Retention Rates	One Year Retention Rates	Two Year Retention Rates	Three Year Retention Rates
Fall 2008	NASC Total	134	97.8 %	88.8 %	89.6 %	83.6 %
	BSPHYSICS	6	100.0 %	83.3 %	100.0 %	83.3 %
Fall 2009	NASC Total	154	98.1 %	91.6 %	87.0 %	83.8 %
	BSPHYSICS	2	100.0 %	100.0 %	50.0 %	50.0 %
Fall 2010	NASC Total	149	98.7 %	93.3 %	90.6 %	85.9 %
	BSPHYSICS	5	100.0 %	100.0 %	80.0 %	80.0 %
Fall 2011	NASC Total	147	98.6 %	92.5 %	86.4 %	81.6 %
	BSPHYSICS	7	100.0 %	100.0 %	100.0 %	85.7 %
Fall 2012	NASC Total	193	97.4 %	91.7 %	86.5 %	
	BSPHYSICS	5	100.0 %	100.0 %	60.0 %	
Fall 2013	NASC Total	189	97.9 %	93.1 %		
	BSPHYSICS	4	100.0 %	100.0 %		
Fall 2014	NASC Total	142	98.6 %			
	BSPHYSICS	4	100.0 %			
	NASC Avg		98.1 %	91.8 %	88.0 %	83.7 %
	BSPHYSICS Avg		100.0 %	97.2 %	78.0 %	74.8 %
	Semesters Retention		1	2	4	6

The physics program at Pepperdine University has a large population of female students. This is unusual for a typical Physics Program found in most universities throughout the United States. In Dr. Fasel's research group during the 2014/2015 academic year he had 6 female research students. There were no males doing research during this academic year. During the current academic year (2015/2016) 10 out of 15 total research students are female. There are five male students (Caucasian/white) in the research group.

In Dr. Mann's current lab 3/6 researchers are female.

This small sample reflects the diversity of the Physics Program at Pepperdine University. One goal of the Physics Program at Pepperdine University is to increase the number of women and people of under-represented ethnicities in STEM (Science Technology Engineering and Mathematics) education.

Please present your student and alumni survey data examining student attitudes, satisfaction levels and dispositions.

The OIE Alumni Survey was conducted during the spring semester of 2015. The survey was sent out to 1562 Natural Science alumni, with a return response of 411 alumni (a 26% response rate). The Physics program had only one alumni that responded. The gender population from this survey is 49.6% males and 50.5% females. The ethnicity is 7.3 % Latino/Hispanic, 7.6% Asian, 73.9% Caucasian/White, 6.4% Bi- or Multi-racial, and 4.9% other. The Physics Program at Pepperdine University has a large population of female students and several students of Latino/Hispanic backgrounds.

Please describe evidence of students' research and publications, awards and recognition, professional accomplishments.

Dr. Fasel's research group has studied data which supports the idea that magnetic reconnection is the main mechanism which transfers energy and momentum from the Solar wind into the Earth's magnetosphere. The research has resulted in several posters which have been presented at the annual fall American Geophysical Union (AGU) meeting in San Francisco, California. This meeting usually has 20,000-24,000 attendees every year. Top scientists from around the world (Europe, Asia, Africa, North and South America) attend the annual AGU conference. This provides an opportunity for the students to meet and discuss science with the top experts in Space Physics. Dr. Fasel has been able to place three students in the past five years in a summer internship at NASA Goddard outside of Washington D.C.. Two of these interns presented their research at the fall AGU conference. All three students presented their research at the weekly Pepperdine Natural Science seminar.

The posters presented by the students working with Dr. Fasel (Pepperdine University) or Dr. Sibeck (NASA Goddard) are listed below:

Students are noted by *
Dec. 2015 "A Study of the Different classes of Poleward-Moving Auroral Forms'', Gerard Fasel, Kate Kononenko*, Ashley Rothballer*, Taylor Brandt*, Maxwell Freeman*, Alex Angelo*, Mashaer Alyami*, David Green, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2014 "Dayside Auroral Activity During Solar Maximum and Minimum Periods'', Gerard Fasel, Megan Rawie*, Julia Flicker*, Mashaer Alyami*, Alexandra Angelo*, Sarah Bender*, David Green, David Sibeck, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2013 "Generation of Poleward-Moving Auroral Forms During Periods of Dayside Auroral Oval Expansions/Contractions and Periods When the Dayside Auroral Oval is Expanded and Stable, Gerard Fasel, Julia Flicker*, David Bermea*, Debbie Sanchez*, Jenny Yoon*, Yahrtiza Orellana*, Christopher Vasquez*, Brandon Hilliard*, Hanna Kristensen*, Jeannie Kim*, Alexandra Angelo*, Michael Christensen*, Sarah Bender*, Carol Ting Hung*, Kevin Chung*, Mashaer Alyami*, Richard Aylward*, Onur Sahin*, David Green, David Sibeck, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2012 "The Connection Between Solar Wind Speed and Poleward-Moving Auroral Forms'', Gerard Fasel, Malia Pantastico*, Julia Flicker*, Carol Ting Hung*, Jenny Yoon*, Erandy Segovia*, Mashaer Alyami*, Yahrtiza Ornella*, Sarah Bender*, Sara Tandon*, Alexandra Angelo*, Christopher Vasquez*, David Sibeck, David Green, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2011 "Motion of Poleward Moving Auroral Forms During a Shift of the Interplanetary Magnetic Field Bz-Component, From a Southward to Northward Orientation", Gerard Fasel, Heather Stancl*, Alex Hakso*, Clay Spackman*, Sean Cook*, David Green, David Sibeck, Fred

Sigerness, Dag Lorentzen. (poster)

NASA Internships that were presented at the AGU conference (Space Physics)
Dec. 2014 “Foreshocks significance in Generation of ULF Waves’’, Alex Angelo*, Olga Gutynska, David Sibeck. (poster)
Dec. 2014 “Morphology and Dynamics of Auroral Arcs’’, Sarah Bender*, Kyle Murphy, David Sibeck. (poster)

Dr. Henisey has also completed some research with students:
1) Raymond McIntyre – Basic numerical modeling and the MRI; no funding; January 2012 to 2013.
2) Onur Sahir – Black Hole X-Ray Binary Accretion States; no funding; May 2012 to 2013.
3) Nathaniel Gruendemann –Dynamical Signatures in X-Ray data; no funding; May 2012 to 2013.
Presentations:
H. Roberson, “Modeling Athletic Strength Among Crossfit Athletes.” Oral Presentation, Southern California Conference on Undergraduate Research, November 2013.

ANALYSIS OF EVIDENCE:Integrity

Are the graduates achieving the student learning outcomes at the expected level? How was the threshold determined? How do you know your expectations are appropriate? Do you use comparisons based on national standards or benchmarking? How have your assessment findings supported this?

The graduates are achieving the student learning outcomes at the expected levels. Our graduates from the Physics Program have successfully entered the work force: Southwest Industries, Inc., Northrup Grumman, Boeing, General Electric, Space-X, and accepted into graduate schools: Stanford University, Rensselaer Polytechnic Institute, Southern Methodist University, Arizona State University, Boston University, Washington University-St. Louis, University of California-Merced, University of California-Davis, University of Southern California San Francisco State University, Fullerton State University, and Loyola Marymount University.

The graduates of the Physics Program who have entered the work force or graduate school have been successful in their endeavors.

We have been in contact with the physics graduates via text. They have provided information regarding their success and how well the Physics Program prepared them for life in the industry or graduate school.

Is there assurance that students consistently meet the standards of performance that the major has established? What happens to students that don't meet the standards?

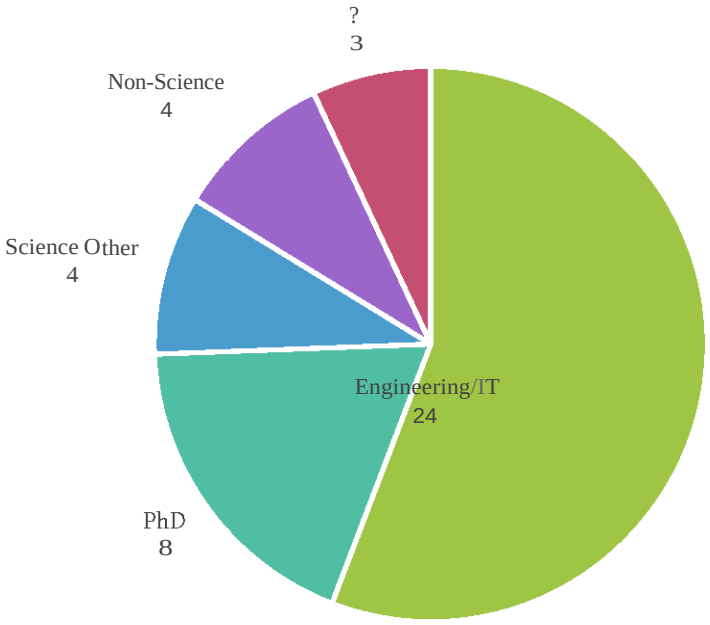
Yes, there is assurance that the students meet the standards of performance for the Physics Major. The courses are interlinked and material from previous courses is constantly reviewed. Exams test the students’ performance throughout the Physics Program. This allows the professor to determine if there are gaps in the base knowledge that the physics student is building. For instance, the modern physics lab (PHYS 380) relies on the modern physics course (PHYS 312) to develop the theoretical background for the experiments that are to be executed in the modern

physics laboratory. If the student does not understand the lab experiment then it is assumed that the student missed an important learning concept from the modern physics lecture course. If situation would occur, the professor would help the student fill in the missing theoretical material. This can be easily accomplished by assigning appropriate reading material supplemented by associated problems. This can be done with any other physics course in the Physics Program. This assures that the physics student will meet the standards of performance for the Physics Major.

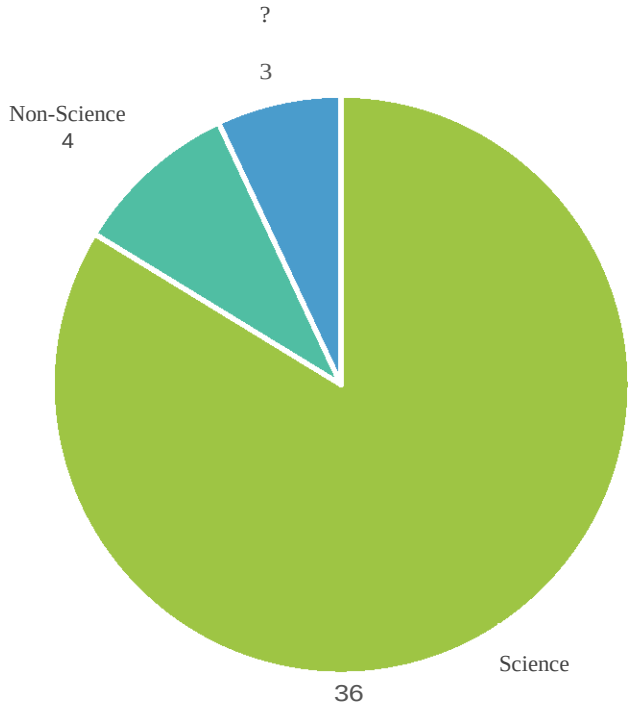
19. Please present an integrated analysis of the data collected from the assessment of direct learning and indirect learning (survey data, focus group, alumni data, and authentic evidence). Please report on the findings from the last comprehensive program review. In summary please explain how the program has achieved a holistic evaluation of the

students' educational experience.

Physics and Natural Science Graduates since 2007



Physics and Natural Science Graduates since 2007



Physics_Alumni_Data.pdf
MCAT_Physical_Sciences.pdf
PHYS_202_Assessment.pdf
Assessment_of_writing_competency_2014_2015.pdf
Physics201_fall2015.pdf
Physics312_fall2015.pdf
Physics425_General_Relativity_Fall2016.pdf
PHYSICS430_THERMAL_spring2016.pdf
Introductory_Physics_I_phy202_spring_2016.pdf
Introductory_Physics_II_PHY_203_Spring_2016.pdf
Phys_210_F15___Syllabus.pdf
Phys_211_S16___Syllabus.pdf
Phys_240___Syllabus.pdf
Phys_330___Syllabus.pdf
PHYS_380_Schedule_S16.pdf
Phys_410___Syllabus.pdf
Phys_411___Syllabus.pdf
Phys_420_F15___Syllabus.pdf
Phys_440___Syllabus.pdf
PHYS_Course_Assessment_Schedule.pdf

Direct learning is accessed via quizzes, exams, and lab write-ups. Quizzes and exams are used in all of the courses required by the Physics Major. PHYS 312 (modern physics) and PHYS 380 (modern physics laboratory) were recently compared and analyzed to see if conceptual concepts and theories studied in PHYS 312 were retained by the students when they took PHYS 380. Dr. Fasel and Dr. Mann had several discussions regarding the information the students studied in PHYS 312 and their ability to use this information in PHYS 380, the lab component of modern physics. The lab reports which were written for PHYS 380 demonstrated that the students did indeed retain, understood, and were able to use information obtained in PHYS 312.

Indirect learning and authentic evidence were evaluated via student research, industry jobs, graduate school admissions, and polling of individual students regarding their experience in the Physics Program at Pepperdine University. The graduates from the Physics Program have been successful in gaining admission to graduate school or being finding jobs in the industry.

The findings from the last five-year review by Dr. Kenneth Kihlstrom included the following suggestions: re-evaluate the learning outcomes, grant Gerard Fasel tenure, equipment is outdated and modern physics lab needed to be upgraded, add a second semester of quantum by eliminating PHYS 420, adding internships, and diversity hires. We have addressed several of the suggestions given by the external reviewer. The learning outcomes were re-evaluated, we now have the following four learning outcomes:
(1) Demonstrate knowledge of the theoretical underpinnings of physics by solving problems in classical mechanics, electromagnetism, thermodynamics, and quantum mechanics,

(2) Recognize the role of observation and experimentation in science by utilizing basic laboratory techniques and data analysis to study physical phenomena,
(3) Communicate experimental results, theoretical solutions, and general knowledge of physics in both written and oral forms,
(4) Foster a culture of science and interest in physics within the greater community by having participated in co-curricular outreach or research activities.

Gerard Fasel was given a tenure track position, Assistant Professor of Physics.

The modern physics laboratory was upgraded and the following items were purchased:
Thor Labs Vis spectrometer
Keithly 2450 source meter
Stanford research systems lock in amplifier
Type II superconductors in 4 wire configuration
n type and p type germanium crystal for Hall Effect
The Natural Science Department has an end of the year budget for major equipment. The Physics Program is compiling a list of equipment that we would like for the lower division laboratories. In particular a complete set of air tracks is being submitted along with new Faraday cages and other items. The Physics Program is submitting a list to the divisional dean by 19 February, 2016.

Two new upper division courses have been added to the curriculum: PHYS 421 (condensed matter), PHYS 425 (General Relativity). These courses may be taken instead of PHYS 420. We are talking about adding a third upper division course, a second semester of quantum mechanics. A lower division course has been added to the Physics Program, PHYS 240 (numerical methods) provides the physics student with an introduction to C++ and develops numerical and computational skills which can be used for upper divisional courses.

Since the last 5-year review Dr. Gerard Fasel has been able to send three students to NASA Goddard for summer internships. Funding permitting, Dr. Fasel will be sending two more students to NASA Goddard for summer internships.

With respect to diversity hires, the Physics department recently hired Mary Holden as a visiting lecturer. She has been a wonderful asset to our department and has done a spectacular job teaching the undergraduate physics courses, PHYS 202 and PHYS 203. Mary is has a B.S. in engineering and a M.S. in Ceramic Science. She is capable of teaching a statics and dynamics course, which is another suggestion made by Dr. Kihlstrom in the last review. Dr. Fasel has spoken to Mary about teaching a statics and dynamics course and she has agreed to teach these courses sometime in the future.

The Physics Program has successfully recruited many women. Last year Dr. Fasel took five women, all research assistants, to the American Geophysical Union meeting where they presented their research via a poster. After the meeting, Dr. Fasel and the five research students (all female) flew to Longyearbyen, Norway to spend a week collecting data from the Kjell Henriksen Observatory.

The Physics Program has moved forward from its last five-year review in many ways. It has diversified, upgraded laboratories, revised learning outcomes, provided internships for the physics students. It has enhanced the students' educational experience by increasing their ability to participate in undergraduate research programs and experience internships at NASA. This has allowed the Physics Program to evaluate how well it has prepared the students for life in industry or academia. The students have been very successful in their research and internships. NASA

has always invited the students back for another summer internship after they successfully completed their first. The students have been very successful at the conferences they have attended. They were prepared to discuss science with the top scientists in Space Physics (those students working with Dr. Fasel). Some students have been offered graduate school admission after impressing professors from other universities with their knowledge of the research project being presented. This is a clear indication that our Physics Program is meeting its objectives.

Please see attached schedule for Physics course assessments over the next seven years. All courses will be assessed via exams. An exam will be given at the beginning of the semester on the fundamental concepts for that particular course. At the end of the course an exit exam (different from the final) will be given on the same basic concepts. For example, PHYS 312 (modern physics course) is a supporting course the advanced course, PHYS 380 (modern physics lab). Giving an exam at the beginning of PHYS 380 will allow us to assess how the previous supporting course (e.g. PHYS 312 modern physics course) prepared the physics students for the modern physics lab. By giving an exit exam in PHYS 380 we will also be able to determine how this advanced course increased the base knowledge of the student.

WASC 5 CORE COMPETENCIES

WASC 5 CORE COMPETENCIES

How does the program ensure that graduates meet the WASC FIVE CORE COMPETENCIES? Present your findings of measurements you have done of the core competencies (may be less than 5).

The Physics Program provides a forum in which the WASC Five Core Competencies are met: Critical Thinking, Quantitative Skills, Written and Oral Communication, and Information Literacy. These items are addressed in both course work and research. The Physics labs PHYS 210 (lower division lab),
PHYS 211 (lower division lab), PHYS 380 (Modern Physics Lab), PHYS 420 (Electronics course: lecture and Lab) require critical thinking, qualitative skills, written and oral communication. Each of these labs requires the physics student to setup and perform an experiment, find and fix problems with an experiment that is not working, write lab reports, and give oral presentations. PHYS 201 requires the students to prepare a scientific oral presentation. Information literacy is accessed in all lecture courses (PHYS 210, PHYS 211, PHYS 312, PHYS 320, PHYS 330, PHYS 410, PHYS 411, PHYS 421, PHYS 425, PHYS 430, PHYS 440) via homework, quizzes, and exams, both written and oral.

The research component fulfills all of the WASC 5 Core Competencies. The research allows students to design experiments, read through the literature to enhance their understanding of the field, prepare abstracts for conference submission, construct oral and poster presentation, present their research at professional meetings, either via oral talks or poster presentations.
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SUSTAINABILITY: RESOURCES

Sustainability

a)Since the inception of the Physics Program the number of physics students has increased. Our first graduating class had only one student, the second graduating class had three students, and the past three academic terms (spring 2013, 2014 and 2015 graduating classes) we had 16 that graduated with a Bachelor of Science in Physics. The Physics Program has seen the number of

Physics minors increase. Last spring (2016) Dr. Fasel spoke with over twenty prospective students that were interested in the Physics Program at Pepperdine University. There is a large national push for STEM education (Science Technology Engineering Mathematics). Physics is the cornerstone for most of the disciplines that support STEM education, most requiring at least one semester of physics. There is a strong need for the Physics Program at Pepperdine University.

b) the degree to which resources are allocated appropriately so they are sufficient to maintain program quality:

There are adequate resources to support and maintain the Physics Program at Pepperdine University. Money is allocated for hiring teaching assistants, tutors, and research assistants for the Physics Program. Each year there is funding for major equipment. With these funds the Physics Program is able to upgrade existing laboratory equipment and purchase new experimental setups. There is also funding available every year for faculty and students to travel to conferences where they can exchange ideas and collaborate with colleagues from different institutions. Current research work is also presented at the conferences providing feedback on ongoing studies. This is also a great forum for the students to begin their scientific training, assembling research for presentation at the specified scientific meeting. Dr. Fasel has taken many students to the annual American Geophysical Union meeting in San Francisco, California. There are also funds to support travel for both students and faculty to various laboratories and observatories. In December 2014 Dr. Fasel accompanied 7 students to the Kjell Henriksen Observatory in Longyearbyen.
There are funding opportunities within the university which are available to the faculty. These funds support the hiring of summer research internships for students.

c) What is happening within the profession, local community, or society that identifies an anticipated need for this program in the future? (If appropriate include market research.):

The current world is based on science and technology. This trend is increasing and it is important to help support the STEM initiative. This will help supply the future generation with qualified people for employment in STEM related jobs. As mentioned before, Physics is the cornerstone for most Science, Technology, Engineering, and Mathematics disciplines. Hence, the need for the Physics Program in the future is justified.

FACILITIES

The Natural Science Division at Seaver College is housed in two main areas, the first to fourth floors of the Keck Science Center (KSC) and the first floor of the Rockwell Academic Center (RAC). The total space allocated to the division is 39,037.5 ft2, and square footage within this space includes offices for faculty and staff, storage areas, support facilities, research and teaching laboratories, and classrooms. There is no immediate space allocated specifically for studying by students, but students are allowed access to empty classrooms during the day as well as the RAC lobby, which is decorated with adequate furnishings. In addition, students are in easy walking distance to the Payson Library.

Of the space allocated to the Natural Science Division, 943 ft2 is used for the main office, stockroom, and tech support. In addition, there is approximately 1,401 ft2 that includes space for office equipment, a break room, adjunct office space, a conference room, and the lobby. Storage space consist of 1,159 ft2. In addition, approximately 1,751 ft2 is used for a vivarium, autoclaves, the stockroom, a cold room, chemical storage, and washroom.

Classrooms for all courses taught by programs in the division are scheduled by the Office

Administrator of the Natural Science Division. Currently, the division has access to 9,801.5 ft2 that is used as classroom space, with classrooms distributed throughout the RAC, KSC, CAC (Cultural Arts Center), and the Plaza. In addition, PLC102, a classroom adjacent to the Payson Library, is used to teach several classes in mathematics. The following is a list of classrooms by student capacity: 1) 50 students - Plaza 188 and KSC 130; 2) 30 students - CAC 124, CAC 125, and RAC 175; 3) 24 students - KSC 100, KSC 110, RAC 170; 4) 16-22 students - KSC 210, KSC 300, KSC 320, KSC 360, RAC 138, RAC 178. Four (KSC 210, KSC 300, KSC 320, KSC 360) of these classrooms are used as teaching laboratories as well as classrooms.

Faculty members have assigned lab space that is used for both research and teaching. Programs most of the laboratory space include Biology, Chemistry, Physics, and Sports Medicine. Collectively, this amounts to approximately 9,788 ft2. Laboratory space utilized primarily for teaching includes 14,956 ft2.
Office space for faculty is located in the RAC and totals 4,240 ft2. In addition, there are two offices in the PLC for one visiting professor in mathematics and the Coordinator of Nutrition's post-baccalaureate program for students interested in becoming Registered Dietitians.

FACULTY AND STAFF
What are the qualifications and achievements of the faculty/staff in the program in relation to the program purpose and goals? How do faculty/staff members' backgrounds, expertise, research, and other professional work contribute to the quality of the program?

a) Proportion of faculty with terminal degrees.
The Physics department has four faculty members, Dr. Fasel (Dr. Philos. Physics, University of Oslo: Space Physics and General Relativity), Dr. Henisey (Ph.D. Physics, University of California-Santa Barbara: Astrophysics), Dr. Mann (Ph.D. Material Science and Engineering, University of California-Riverside: Material Science) and Mary Holden (M.S., Alfred University: Cermaics).

b) List of faculty/staff specialties within discipline (and how those specialties align with the program curriculum).
Courses taught by Dr. Fasel: PHYS 201 (first year physics seminar), PHYS 202 (basic physics 1), PHYS 203 (basic physics 2), PHYS 210 (Physics for Scientists and Engineers 1), PHYS 211 (Physics for Scientists and Engineers 2), PHYS 312 (modern physics), PHYS 320 (mathematical physics), PHYS 330 (classical mechanics), PHYS 410 (electromagnetism 1), PHYS 411 (Electromagnetism 2), PHYS 425 (general relativity), PHYS 430 (thermal and statistical mechanics), PHYS 440 (quantum mechanics), PHYS 490 (introduction to research).

Courses taught by Dr. Henisy: PHYS 202 (basic physics 1), PHYS 203 (basic physics 2), PHYS 210 (Physics for Scientists and Engineers 1), PHYS 211 (Physics for Scientists and Engineers 2), PHYS 320 (mathematical physics), PHYS 330 (classical Mechanics), PHYS 410 (Electromagnetism 1), PHYS 411(Electromagnetism 2), PHYS 440 (quantum mechanics).

Courses taught by Dr. Mann: PHYS 202 (basic physics 1), PHYS 203 (basic physics 2), PHYS 210 (Physics for Scientists and Engineers 1), PHYS 211 (Physics for Scientists and Engineers 1), PHYS 380 (modern physics lab), PHYS 420 (electronics).

Courses taught by Mary Holden: PHYS 202 (basic physics 1), PHYS 203 (basic physics 2).

c) Record of scholarship for each faculty member, professional presentations for staff members.

Dr. Fasel
Dr. Fasel has been a convener/chair for the following AGU conferences:

Sessions at American Geophysical Union (AGU)(Space Physics) where I have been a Convener and Chair:
Dayside Transients (AGU 2012)
Solar Wind Influence on Dayside Transients (AGU 2013)
Solar-Terrestrial Interactions: Dayside Transients in the High-Latitude Ionosphere and Magnetosphere (AGU 2014)
Magnetospheric Response to Transient Solar Wind Phenomena (2015)

Dr. Fasel's Contributed Papers (oral or poster) with students:
Students denoted by *
Dec. 2015 "A Study of the Different classes of Poleward-Moving Auroral Forms'', Gerard Fasel, Kate Kononenko*, Ashley Rothballer*, Taylor Brandt*, Maxwell Freeman*, Alex Angelo*, Mashaer Alyami*, David Green, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2014 "Dayside Auroral Activity During Solar Maximum and Minimum Periods'', Gerard Fasel, Megan Rawie*, Julia Flicker*, Mashaer Alyami*, Alexandra Angelo*, Sarah Bender*, David Green, David Sibeck, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2013 "Generation of Poleward-Moving Auroral Forms During Periods of Dayside Auroral Oval Expansions/Contractions and Periods When the Dayside Auroral Oval is Expanded and Stable, Gerard Fasel, Julia Flicker*, David Bermea*, Debbie Sanchez*, Jenny Yoon*, Yahrtiza Orellana*, Christopher Vasquez*, Brandon Hilliard*, Hanna Kristensen*, Jeannie Kim*, Alexandra Angelo*, Michael Christensen*, Sarah Bender*, Carol Ting Hung*, Kevin Chung*, Mashaer Alyami*, Richard Aylward*, Onur Sahin*, David Green, David Sibeck, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2012 "The Connection Between Solar Wind Speed and Poleward-Moving Auroral Forms'', Gerard Fasel, Malia Pantastico*, Julia Flicker*, Carol Ting Hung*, Jenny Yoon*, Erandy Segovia*, Mashaer Alyami*, Yahrtiza Ornella*, Sarah Bender*, Sara Tandon*, Alexandra Angelo*, Christopher Vasquez*, David Sibeck, David Green, Fred Sigernes, Dag Lorentzen. (poster)

Dec. 2011 "Motion of Poleward Moving Auroral Forms During a Shift of the Interplanetary Magnetic Field Bz-Component, From a Southward to Northward Orientation", Gerard Fasel, Heather Stancl*, Alex Hakso*, Clay Spackman*, Sean Cook*, David Green, David Sibeck, Fred Sigerness, Dag Lorentzen. (poster)

NASA Internships that were presented at the AGU conference (Space Physics)
Dec. 2014 "Foreshocks significance in Generation of ULF Waves'', Alex Angelo*, Olga Gutynska, David Sibeck. (poster)
Dec. 2014 "Morphology and Dynamics of Auroral Arcs'', Sarah Bender*, Kyle Murphy, David Sibeck. (poster)

Dr. Fasel's Recent Publications
Fasel, G.J. and A. Otto, 'On the Generation and Source Region of Pole-Ward Moving Auroral Forms', (in Prep, to be submitted to Geophysical Research Letters).
Fasel, G.J. and L.C. Lee, 'Three classes of dayside poleward-moving Auroral forms and their relationship to dayside merging', (in Prep., to be submitted to Journal of Geophysical Research-Space Physics).

Dr. Mann Publications
Chemical vapor deposition growth of a periodic array of single-layer MoS2 islands via lithographic patterning of an SiO2/Si substrate. 2D Mat., 2015, 2 (4), 2015.
Scalable fabrication of a hybrid field-effect and acousto-electric device by direct growth of

monolayer MoS2/LiNbO3. Nat. Comm., 2015, 6, 8593, 2015.
Superlinear Composition-Dependent Photocurrent in CVD-Grown Monolayer MoS2(1–x)Se2x Alloy Devices. Nano Lett., 2015, 15 (4), pp 2612–2619, 2015.
Postgrowth Tuning of the Bandgap of Single-Layer Molybdenum Disulfide Films by Sulfur/Selenium Exchange. ACS Nano, 2014, 8 (5), pp 4672–4677 , 2014.
2-Dimensional Transition Metal Dichalcogenides with Tunable Direct Band Gaps: MoS2(1-x)Se2x Monolayers. Advanced Materials Volume 26, Issue 9, pages 1399–1404, March 5, 2014, 2014.
A direct comparison of CVD-grown and exfoliated MoS2 using optical spectroscopy. 2014 Semicond. Sci. Technol. 29 06400, 2014.
Facile growth of monolayer MoS2 film areas on SiO2. The European Physical Journal B 86, 1-4(2013), 2013.
Controlled argon beam-induced desulfurization of monolayer molybdenum disulfide. Journal of Physics Condensed Matter, 25 252201, 2013.

Dr. Henisey Publications
Generozov, A., Blaes, O., Fragile, P. C., & Henisey, K. B. (2013). Physical properties of the inner shocks in hot, tilted black hole accretion flows. The Astrophysical Journal, 780(1), 81.
Henisey, K. B., Blaes, O. M., & Fragile, P. C. (2012). Variability from Non-axisymmetric Fluctuations Interacting with Standing Shocks in Tilted Black Hole Accretion Disks. The Astrophysical Journal, 761(1), 18.
Henisey, K. B. (2011). Black Hole Accretion Dynamics in Numerical Simulations.

Dr. Henisey Presentations
Invited Colloquium Speaker, East Lost Angeles College, “Blobs, Shocks, and Spirals: Complex Dynamics in Black Hole Accretion.” 2012
Invited Speaker, Sigma Phi Epsilon RLC Lecture, “Modern Physics, Determinism, and Free Will." 2012
“Non-modal Variability in Black Hole Accretion,” 2010, 4th Annual Santa Barbara Astrophysics, KITP.

d) Faculty/staff participation in development opportunities related to teaching, learning, and/or assessment.
Each of the faculty members works on enhancing their courses by reading the literature in physics: American Journal of Physics, Physics Teacher, European Journal of Physics, Physical Review Letters, Journal of Geophysical Research-Space Physics, Planetary and Space Sciences, Geophysical Research Letters, etc. The physics faculty meets on a regular basis to talk about teaching methods for lectures and how to improve laboratory component of the curriculum. The laboratory equipment is assessed to determine what needs to be upgraded and what new equipment would enhance the laboratory. Meetings also provide opportunities to listen to talks regarding teaching methods in the twenty first century. The Natural Science faculty meet once a month. During these meetings new technology offered by Pepperdine is made known to the faculty along with any other information that would have a positive impact on teaching.

e) External funding awarded to faculty/staff.
Currently Dr. Fasel is finishing a proposal which will be submitted to NSF, Magnetospheric Physics (to be submitted March 2016). Dr. Fasel is also working on funding through the G. Unger Vetlesen Foundation with Miyun Choe and Sheila King (Office Foundation Relations, to be submitted April 2016).

Curriculum Vitae available for all faculty

FACULTY/STAFF
Are there sufficient numbers of faculty/staff to maintain program quality? Do program faculty/staff have the support they need to do their work?
and research funds)

a) Distribution of faculty across ranks (or staff years at institution):
Dr. Henisey, Dr. Mann, and Dr. Fasel are all ranked as Assistant Professor of Physics. Mary Holden has the position of Visiting Lecturer in Physics.

b) Diversity of faculty/staff:
The Physics faculty consists of three males and one female.

c) Number of full-time faculty (ratio of full-time faculty to part-time faculty):
The Physics group are all full-time faculty members.

d) Student-faculty ratio:
The student-faculty ratio from 2011-2015 is 22.4 for lectures and 11.9 for laboratory classes.

e) Faculty workload:
The physics faculty workload is as follows: Dr. Fasel: 21 units per year, Dr. Henisey: 21 units per year, Dr. Mann: 21 units per year, Mary Holden: 32 units per year.

f) Faculty review and evaluation processes:
All full-time and visiting faculty in the Natural Science Division are asked to complete an Annual Faculty Activity Form. This form asks each member of the faculty to outline his or her activities in the areas of scholarship, teaching, and service. The Divisional Dean of the Natural Science Division reviews each of these annual reports and assesses student teaching evaluations of courses taught by each member of the faculty. After evaluating each report, the Divisional Dean provides written feedback of the faculty member's teaching and achievement, and the faculty member is asked to provide any written comments related to the evaluation. In addition, the Divisional Dean has one on one conversations with any faculty member needing further follow-up to the evaluation.

For full-time members of the faculty, each rank (e.g. Assistant, Associate, and Full Professor) has three steps. Based on information related to a faculty member's scholarship, teaching, and service, the Divisional Dean can recommend a step increase within a particular rank to the Dean of Seaver College, who makes the final decision regarding the step increase. Promotion to a higher rank, such as Assistant Professor to Associate Professor or Associate Professor to Full Professor, requires an evaluation by the Rank, Tenure, and Promotion (RTP) Committee, which consists of voting tenured representatives from each division in Seaver College as well as a non-tenured professor. For promotion in rank, the faculty member must provide information on Teaching Effectiveness, Scholarly Activity, and Service (professional, university, division, community). With the approval of the Divisional Dean, the candidate for promotion is asked to designate five peer reviewers, who will be asked to evaluate the information provided by the candidate. Each of these designated reviewers will provide a formally written response to each of the major categories, and the Divisional Dean will provide an independent response that includes details of the faculty member's teaching evaluations submitted by students. The RTP committee evaluates the evidence and makes a recommendation to the Dean of Seaver College, who has independently evaluated all of the evidence submitted on behalf of the candidate. The Dean's recommendation is then sent to the Provost and President.

The above outlined procedure is basically the same used for an individual submitting for tenure

and promotion. All members of the faculty considered tenure-track receive a pre-tenure review that uses the same criteria as those outlined for tenure and promotion. This review occurs mid-tenure and is designed to provide constructive feedback concerning teaching, scholarship, and service. It also allows for the college to determine whether or not the faculty member should continue. If the evaluation suggests no reappointment, the faculty member is allowed to stay the following year prior to termination. If the reappointment is approved, the Divisional Dean and faculty member will go over the RTP report and decide the best course of action to address any identified weaknesses.

After tenure, each member of the faculty receives a five-year evaluation. The basic procedures are similar to those outlined for tenure and promotion, except only three designated peer reviewers are required. The RTP committee makes a recommendation to the Dean of Seaver College, and the Dean decides the appropriate merit raised based on the outcome of the evaluation.

g) Mentoring processes:
All pre-tenured members of the faculty are assigned a senior mentor by the Associate Dean. In addition, the Associate Dean schedules workshops related to navigating the tenure process. All tenured and tenure-track faculty are required to submit a detailed annual report that outlines their pedagogy, scholarship, and service. The Divisional Dean of Natural Science evaluates these reports and examines student evaluations taught by each member of the faculty. After this initial evaluation, the Divisional Dean writes a formal assessment and provides information on student evaluations for the courses taught. The faculty member also is provided a written response from the Divisional Dean. After the faculty member receives this evaluation, the Divisional Dean and the faculty member meet to discuss any issues raised in the evaluation. The faculty member is provided an opportunity to provide a written response. Both the mid-tenure and five year reviews also provide each faculty member with input as to his or her progress.

h) Professional development opportunities and resources (including travel and research funds):

There are funds that are available to the faculty for both professional travel and research. Each faculty is allotted monies for travel to one professional meeting per year. Funding is also available for research, funding for student research assistants, computers and software needed for research, and major equipment needed for experimental setups. These funds are made available through the university and donors.
The university continually offers professional developmental courses throughout the year: computing, new technology, etc.

i) Sufficient time for research, program development:
There is sufficient time for research and program development throughout the year. After the spring semester there are four months that are available for research, writing papers or proposals, and enhancing the Physics Program. The faculty members are around for most of the summer months and meet occasionally to discuss the direction of the Physics Program.

Physics Student Faculty Ratios

Student Faculty Ratio = Total students enrolled/Total faculty

Faculty were counted as many times as the courses they taught.

Semester	Lecture	Lab
Sp11	26.8	11.3
Fa11	22.3	12.5
Sp12	21.4	13.1
Fa12	27.0	13.3
Sp13	21.3	9.5
Fa13	24.8	15.5
Sp14	21.4	9.5
Fa14	19.0	7.5
Sp15	20.0	14.0
Fa15	20.6	12.6
Average	**22.4**	**11.9**