

# PORTLAND COMMUNITY COLLEGE PHYSICS SACC

## PROGRAM/DISCIPLINE REVIEW 2009-2010 Academic Year

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## Changes since the Program/Discipline Review of 2001

### Physics Labs

The primary concern addressed in the previous Program Review was the inequality between lab facilities at the three campuses of PCC. At the Sylvania campus in particular, lab equipment was old and outdated, and the design of the lab itself prohibited the addition of computers at each lab station. The absence of computer-based data acquisition in Physics labs at our largest campus was then cited as a major weakness. Overall, both Cascade and Sylvania fell short of having the lab equipment and facilities found at the Rock Creek campus, causing our Physics labs to differ vastly between the three campuses. Following that Program Review, the labs at Cascade and Sylvania were both updated considerably. Physics labs at all three campuses now incorporate computers which, along with data acquisition software and interface equipment, are utilized in all Physics courses.

### Audio-Visual equipment

Also cited in our previous Program Review, was the inconsistency in the quality and availability of audio-visual equipment, such as In-Focus systems. At that time all faculty expressed an interest in incorporating multimedia in the classroom, however most were reluctant due to the fact that relying on the equipment to be delivered and in working order often proved problematic. Fortunately these issues have been resolved by the presence of podium systems (including instructional computers, DVD players, LCD projectors, and overhead projector screens) in all classrooms. Now that this equipment is widely available, it is utilized daily at all three campuses. This has drastically improved the quality of instruction in Physics courses, allowing us to incorporate Power Point presentations, videos, animations, online resources, and to easily demonstrate lab equipment.

### Enrollment

Data between comparable terms (winter 2001 vs. winter 2010) shows that overall enrollment in Physics courses at PCC during this period has increased by a remarkable **42%**. The majority of this growth has taken place at the Cascade campus (at which enrollment has grown by an extraordinary **487%**). Cascade now regularly offers all three introductory Physics series (conceptual, algebra-based, and calculus-based). Unfortunately, this growth has not been accompanied by the addition of any new full-time faculty positions in the last decade although this need was anticipated in our last Program Review. This issue will be discussed extensively in section 4 (Faculty).

### New Courses

The development and addition of two new Physics courses (PHY 102 and PHY 103) to the existing PHY 101 course created a new "Fundamentals of Physics" series. This broadened the range of topics in conceptual Physics courses offered at PCC to include subjects such as heat, waves, sound, light, electricity and magnetism.

## 1. Discipline Goals

Physics is the root discipline of science that describes the natural universe at its most fundamental level. Physics is relevant to a broad range of academic pursuits including chemistry, biology, engineering, medicine, and liberal arts. Physics allows students to view the world with a new understanding and appreciation of its order and beauty.

Although the technological resources with which we achieve our goals have changed dramatically since the last Physics discipline review, our primary goals and objectives have not fundamentally changed in the last five years, nor do we expect them to change in the next five years.

The AAPT (American Association of Physics Teachers), in its "Guidelines for Two-Year College Physics Programs" states that:

*New technology and Physics education research are constantly changing the way introductory Physics is taught. Two-year college Physics programs have been in the forefront of improving introductory Physics education because of the focus on student learning at two-year colleges.*

*"Diversity" most aptly describes the Physics courses offered in two-year colleges. The need for a wide variety of courses arises from the service role of the Physics department. Two-year colleges offer several levels of transfer courses including courses for students pursuing careers in the physical sciences and engineering; courses for students pursuing careers in life science, medicine, and other professional programs; and courses for nonscience majors including students who are preparing to be elementary school teachers. Specialized courses in Physics are often offered for students in specific two-year vocational and technical programs.*

*Physics is an experimental science. Therefore, laboratory experiences should be an integral part of the Physics curriculum. Excluding experimental learning experiences in Physics is analogous to the elimination of physical training from the physical education curriculum or the de-emphasis of practice on a musical instrument in a music program. Students have more difficulty understanding the relationship between physical theory and experimental evidence without the personal experience of designing and conducting experiments.*

Physics courses at PCC are designed and implemented in accordance with these guidelines. Faculty stay up to date on the latest Physics teaching research and methodologies. Laboratory exercises play a key role in instruction, and comprise half of all hours spent in the classroom. Labs are carefully designed to complement material presented in the lecture, thereby enhancing student learning.

Additionally, we have established a more detailed set of outcomes, shared by all of our Physics courses.

After completion of any Physics course at PCC, students will

1. have an increased awareness of the Physics behind phenomena observed in everyday life, including an understanding of our natural and technological environments.
2. be able to apply abstract mathematical and physical principles to specific problems such as those presented in the homework and on tests, and to reason both qualitatively and quantitatively.
3. be able to apply these same principles when confronted with similar situations in the real world, taking into account factors such as reasonable approximation and limitations due to uncertainty.
4. have strengthened mathematical skills due to the constant application of mathematics in Physics.
5. be able to design experiments and acquire data with the goal of verification of physical principles.
6. have the ability to communicate experimental procedures and results clearly and effectively through a written lab report.
7. have an appreciation for the historical advancement of Physics, and its relation to other disciplines.

By achieving these outcomes we provide students with a foundation and appreciation for science, in addition to introducing valuable life skills. PCC offers a wide variety of courses in accordance with the needs of other programs and disciplines, as well as courses that address the needs of entering students with various backgrounds and abilities. Physics courses prepare students for further study in all of the sciences. Additionally, these courses provide ideal applications for the use of mathematics and communications skills. In this way, the discipline of Physics plays an important role in fulfilling the mission, values, and goals of PCC:

#### **MISSION**

*Portland Community College provides access to an affordable, quality education in an atmosphere that encourages the full realization of each individual's potential. The college offers opportunities for academic, professional, and personal growth to students of all ages, races, cultures, economic levels, and previous educational experiences.*

In support of PCC's mission statement, six specific goals are listed. These are outlined below along with the ways in which the discipline of Physics addresses each goal.

***Goal 1 – Access:*** *We will improve access to quality lifelong learning opportunities through the effective use of technology, affordable classes and the strategic location of facilities.*

- All three introductory Physics series (PHY 101, 102 & 103; PHY 201,202 & 203; and PHY 211,212 & 213) are now offered on a regular basis at all three main campuses of PCC. The North Portland location of the Cascade campus provides access to this revitalized and developing area. The Sylvania campus serves the greater Southwest and downtown Portland areas. The Rock Creek Campus serves the Beaverton-Hillsboro area, and is conveniently located for the growing population in the high-tech corridor.
- Access is also provided for our students by the use of technology. Many instructors have developed detailed web pages in support of their courses. In addition, most instructors utilize the MyPCC portal and its many useful online course tools. These include announcements, links, a course calendar, message boards, chat, and email, among other things. The course tools feature that is most widely used by Physics faculty is the ability to post files such as syllabi, lecture notes and assignments, so that students may have access to these materials at all times.
- Finally, in order to improve access to an even greater extent, PHY 101 is now offered in a hybrid Distance Learning modality. Because of the established importance of hands-on laboratory exercises, the lab still meets weekly on campus. This hybrid format reduces the hours spent on campus by one-half, clearly improving access issues for many students.

***Goal 2 – Student Success:*** *We will promote success for all students through outstanding teaching, student development programs, and support services in all that we do;*

*Professional technical education will be responsive to industry needs and prepare students to work in a global marketplace.*

- Courses offered by the Physics department support many of PCC's professional and technical programs. These include Mechanical Maintenance, Aviation Science, Bioscience, Electronic Engineering, Facilities Maintenance, and Microelectronics. The Physics SACCC maintains communication with these programs to assure that our curriculum and scheduling meet their specific needs.

*Transfer preparation will prepare students for success in obtaining baccalaureate degrees.*

- Physics courses at PCC prepare students for a major in Physics at a four-year university, or future study in related fields such as Chemistry, Biology, Engineering and Medicine. In addition, all Physics courses we offer are on the General Education List and meet the requirements of the

Oregon transfer degree (AAOT). Since many of our students eventually transfer to four-year programs in the Oregon University System, the Physics SACC takes this into consideration in designing all of its courses.

*College readiness will promote student preparation for college-level programs and employment.*

- Students in Physics courses at PCC receive individual attention and constant feedback. This is facilitated by our smaller class sizes, whereas in a university setting comparable classes may have over 200 students. It is to a student's advantage to become familiar with the rigors of college work in a community college setting. The skills acquired here promote success at a four-year university and in the world of employment.

***Goal 3 – Diversity:*** *We will enrich the educational experience by committing to the development of diversity in our student body, faculty and staff.*

- Members of the Physics SACC maintain an awareness of PCC guidelines for diversity (race, ethnicity, gender, and sexual orientation) in faculty by recruiting individuals from all backgrounds.
- Physics instructors also recognize and honor diversity within our student population. Different learning styles are acknowledged by utilizing various instructional strategies and presenting material in many different ways.
- Diversity is also recognized in the form of widely varying educational goals. Physics is offered at several different levels in order to make the subject accessible to those with many differing instructional needs.

***Goal 4 – Continuous Improvement:*** *We will develop, safeguard and allocate our resources (human, financial, capital, and technological) to ensure through planning and assessment the delivery of relevant, quality programs and services.*

- We continue to make certain that our Physics labs incorporate the latest developments in technology, including computers with the most up-to-date data acquisition software and interface equipment. Consequently, we will continue to update our lab exercises accordingly and share these developments with all members of the Physics SACC.
- We will also work with PCC's computer technology specialists to stay informed of new developments in audio-visual equipment that may improve the quality of our lectures.
- Physics faculty regularly engage in professional improvement activities in order to constantly improve upon our instructional skills.

- Physics faculty also frequently have students complete course evaluations to gather information and feedback.

***Goal 5 – Cultivating Partnerships:*** *We will effectively respond to the educational needs of our students and communities through strategic alliances with business, government agencies and educational institutions.*

- Because of our participation in the PAVTEC Dual Credit program, the Physics SACC has made it possible for hundreds of high school students to earn early college credit for coursework completed in high school. Physics faculty have an ongoing role in this program, as we are responsible for approving Physics curriculum and teachers.
- Through our partnership with the Oregon Space Grant NASA consortium, our students have the opportunity to apply for NASA Space Grant scholarships and participate in summer research programs and mentored internships.
- PCC's participation in the UCORE program (Undergraduate Catalytic Outreach & Research Experiences) gives first year college students the opportunity to spend the summer at the University of Oregon and participate in a paid 10-week summer research program. When these students return to PCC for their second year, they work with faculty to help other students succeed in the physical sciences.
- Our partnerships with Intel and other local semiconductor companies initially created the Microelectronics Program and continue to bring considerable numbers of students to PCC from the surrounding community.

***Goal 6 – Community:*** *We will facilitate growth and development of our district communities by accepting a leadership role and serving as a key educational resource to the community.*

- An excellent example is the community education class on Global Climate Change that Toby Dittrich has worked to develop and implement. The online course is designed to help the general public understand the impact of global climate change, and it features many experts on global climate.
- Physics faculty members also play a role in the community by judging for events such as the PCC Science Expo, the Intel Science Expo, and many other science fairs.
- By volunteering to be a translator for students requiring assistance with registration, counseling, and advising, Leonid Minkin also provides a valuable service at PCC.
- Now that science tutoring is widely available, Physics instructors also dedicate time to tutoring in the learning centers located at each campus.

## 2. Curriculum Assessment and Development

### 2.1. National discipline guidelines

The following excerpts are taken from the "Guidelines for Two-Year College Physics Programs" published by the AAPT (American Association of Physics Teachers). This document can be found in its entirety at <http://www.aapt.org/Resources/upload/TYCGuidelines-PDF.pdf> . This booklet was in fact designed in part as "a guide for institutional self-studies and Program Reviews".

- The AAPT guide cites several universal student goals within the populations of two-year colleges:
  - to prepare for transfer to a four-year university;
  - to acquire skills needed for a new occupation;
  - to acquire skills needed for a current occupation;
  - to fulfill a personal interest; and/or
  - to improve basic skills.

All Physics courses offered at PCC are on the general education transfer list and help to improve basic skills through the application of various levels of mathematics and reasoning skills. In addition, many of these courses are either required or recommended for various career/technical programs. In this way, our Physics courses help students to achieve each and every one of the above listed goals

- The AAPT guide cites other major student goals specific to the discipline of Physics:
  - utilizing an instructional format that identifies and addresses students' misconceptions concerning Physics;
  - incorporating computers and other technology into the instructional program.

Both of these goals are constantly addressed both in the way that our Physics courses are designed and implemented, and in the way that our outcomes are routinely assessed.

- AAPT Curriculum Guidelines specify that Physics course offerings should be consistent with the needs of the population that the college serves. These needs include:
  - Physics Courses for Nonscience Majors
  - Introductory Astronomy
  - One-Year College Physics, Algebra/Trigonometry-Based Transfer Courses
  - University Physics and Other Calculus-Based Transfer Courses

All of these courses are now and have traditionally been offered at PCC.

- AAPT Curriculum Guidelines also specify that a variety of activities that actively engage the student must be included in any Physics course. I was pleased to learn that most of us are conducting our classes in precisely the manner suggested in the AAPT Guidelines:

"Instructors should be encouraged to use class time in whatever way they believe maximizes student learning for a particular group of students on a particular topic. There are many possible uses of this time (beyond the instructor lecturing) including: class discussions, using pencil and paper exercises to address student misconceptions, and having students work on problems in groups."

In addition to these suggestions, I know that many of us routinely incorporate conceptual group problems, brief lab activities during lecture, guided inquiry exercises, and interactive lecture demonstrations.

- As far as laboratory guidelines, the AAPT cites three major suggestions:
  - All introductory Physics courses should include a minimum of two hours per week in a laboratory experience. Laboratory sessions for science major courses should be a minimum of three hours per week.  
  
All of our Physics courses at PCC, for both science majors and non-science majors incorporate three hour lab sessions each week
  - Laboratory experiences should extend beyond the completion of a recipe of prescribed activities.  
  
Our labs are specifically designed to avoid the type of robotic measurement and calculation that can be completed without giving serious thought and consideration to the subject material. In many instances, the students are asked to play a role in designing the experiment necessary to observe physical laws and properties.
  - Laboratory sessions should be completely under the guidance of a qualified Physics instructor.

Our instructor qualifications are fortunately identical for both lecture and lab instructors, so labs are always taught by a fully qualified Physics instructor.

## 2.2. Curriculum changes

The largest change in the Physics curriculum since our last Program Review was the addition of two new courses. We introduced PHY 102: Fundamentals of Physics II and PHY 103: Fundamentals of Physics III to complete a full three quarter series when combined with the existing course PHY 101: Fundamentals of Physics I. These courses allow students to take a Physics series that meets the requirement of a full laboratory science series. In order to strengthen enrollment we also designed these courses to be stand-alone. Students can therefore take courses in this series in any order. This flexibility has benefitted the students and strengthened the enrollment in these courses.

Tony Zable led the effort to write the CCOG's for these courses as well as getting the courses approved by both the SACC and the EAC in 2002. The courses were introduced for the first time in the Winter and Spring of 2003. Several faculty members worked on developing the class materials and new laboratories for these courses. Over a three year period faculty members received six IIP grants to develop materials for these courses. The courses have proved to be successful with 6 sections now typically offered each year district wide (3 sections of PHY 102 and 3 sections of PHY 103).

In many of our classes we have introduced inquiry based learning. A variety of different methods are employed, depending on the preferences of individual instructors. A common approach is to pose conceptual questions to the students after covering a specific topic. Students work in pairs or groups, discussing the question amongst themselves. This not only improves the students' understanding of the topics but also greatly improves student engagement. This method is particularly helpful in longer format classes. Cascade campus actually took inquiry based learning into account when designing their new Physics classroom space.

Another innovation introduced to improve student learning was the introduction of split lecture-laboratory format classes. Rock Creek Campus has long offered science classes that meet only twice a week. The advantage of this format is that it improves student access. However, particularly for 100-level students, this is a pedagogical challenge. The Physics department at Rock Creek decided to try splitting each three hour class meeting into half lecture and half lab for some of the courses. This method was applied to the PHY 101 series with great success. Students are better able to grasp the material in smaller units and are able to follow-up lecture topics immediately with hands-on experiments. The success of this split lecture-lab method in our Physics classes led to the General Science (GS) program adopting the same format for all their classes at Rock Creek.

Here are a couple of comments from students regarding this class format:

- "The teacher's method of splitting the class into lecture/lab instead of just either lecture or lab gives the class more variety and helps students learn"
- "Every day we had a lab related to what we were learning about. It was good to have extra hands on type learning."

### 2.3. Physics Intended outcomes

The Course Content and Outcome Guidelines (CCOG's) of all Physics courses contain a set of common intended outcomes which are outlined below:

***Students completing a Physics course at PCC should:***

1. have an increased awareness of the Physics behind phenomena observed in everyday life, including an understanding of our natural and technological environments.
2. be able to apply abstract mathematical and physical principles to specific problems such as those presented in the homework and on tests, and to reason both qualitatively and quantitatively.
3. be able to apply these same principles when confronted with similar situations in the real world, taking into account factors such as reasonable approximation and limitations due to uncertainty.
4. have strengthened mathematical skills due to the constant application of mathematics in Physics.
5. be able to design experiments and acquire data with the goal of verification of physical principles.
6. have the ability to communicate experimental procedures and results clearly and effectively through a written lab report.
7. have an appreciation for the historical advancement of Physics, and its relation to other disciplines.

***In addition the PHY 201 series also requires that students:***

8. be prepared for future study in Pre-Medicine, Biology, Geology, or related fields.

***For the PHY 211 series the additional requirement is that students:***

8. be prepared for future study in Engineering, Chemistry, advanced Physics, or related fields.

In the following sections we will discuss how these outcomes intersect with PCC Core outcomes and also how these outcomes are assessed.

## 2.4. PCC Core outcomes

Below is a discussion of how the Physics Intended Outcomes map onto the PCC Core outcomes. The numbers for the Physics Intended Outcomes refer to the numbers outlined in the previous section.

- **Communication**

*Communicate effectively by determining the purpose, audience and context of communication, and respond to feedback to improve clarity, coherence and effectiveness in workplace, community and academic pursuits.*

Physics Intended Outcomes 1, 3 and 6 all address the requirement that students be able to effectively communicate what they have learned in their Physics classes in both technical environments as well as to the general public. Written lab reports require students to develop strong technical writing skills which we feel is important preparation for students going to work in technical disciplines.

- **Community and Environmental Responsibility**

*Apply scientific, cultural and political perspectives to natural and social systems and use an understanding of social change and social action to address the consequences of local and global human activity.*

Physics Intended Outcomes 1, 3 and 7 emphasize that students should understand how Physics fits within wider social and historical contexts. In addition, Toby Dittrich (Physics, Sylvania), offers a community education course on Global Climate Change sponsored in part by the Oregon NASA Space Grant program.

- **Critical Thinking and Problem Solving**

*Identify and investigate problems, evaluate information and its sources, and use appropriate methods of reasoning to develop creative and practical solutions to personal, professional and community issues.*

Critical thinking and Problem Solving is a key skill that we seek to develop in Physics. This outcome is essentially addressed in all of our outcomes but most specifically in Physics Intended Outcomes 2, 4 and 5. Constant work on complex homework problems as well as dealing with more real world, less clearly defined problems encountered during lab experiments gives students exposure to many different problem solving skills. All courses strongly emphasize developing a process for solving problems. Physics questions the very nature of everything in our universe and requires students of the subject to think critically about every aspect of our world.

- **Cultural Awareness**

*Use an understanding of the variations in human culture, perspectives and forms of expression to constructively address issues that arise out of cultural differences in the workplace and community*

While cultural awareness is not as directly discussed in our courses it is partially addressed in Physics Intended Outcomes 1 and 7. An appreciation of the history of Physics places the science in a wider social context. For example, the historical interaction between physical sciences and religion brings up many cultural issues.

- **Professional Competence**  
*Demonstrate and apply the knowledge, skills and attitudes necessary to enter and succeed in a defined profession or advanced academic program*

All of our intended outcomes address issues of professional competence but Physics Intended Outcomes 3, 6 and 8 specifically call for the demonstration of professional conduct.

- **Self-Reflection**  
*Assess, examine and reflect on one's own academic skill, professional competence and personal beliefs and how these impact others.*

Again, all our outcomes broadly cover this self-reflection outcome. Physics Intended Outcome 3 requires students to process the concepts they learn and then re-apply them to the more complex problems they are faced with in the real world. Outcome 5 requires students to set up experiments, gather data, analyze the data and reflect on how the results relate to physical principles. Several of the Physics Intended Outcomes require students to reflect on what they have learned and place this new knowledge within the context of history and the world around us.

## 2.5. Meeting core outcomes

### 2.5.1. Knowledge and critical thinking assessment

In order to demonstrate the improvement in student performance we designed and administered a simple test consisting of 6 questions that covered the key topics taught during the first course in all of our Physics series.

The design criteria were that the test:

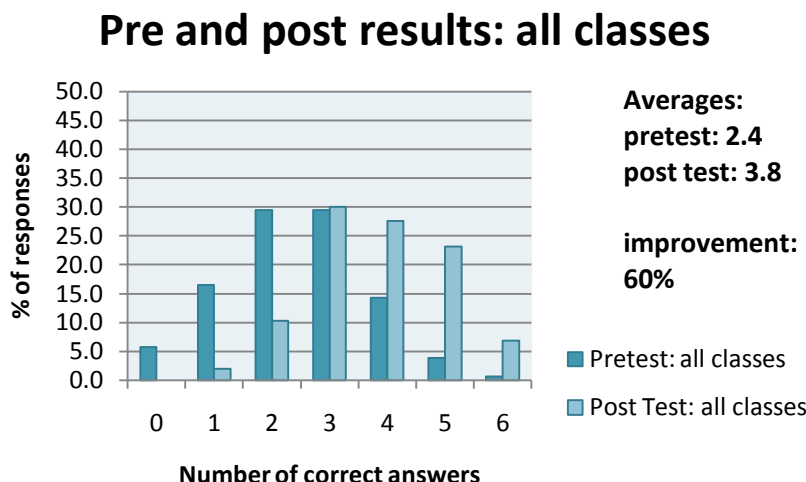
1. could be taken by all three series (PHY 101, PHY 201 and PHY 211).
2. should have minimal impact on instruction time.
3. would show whether student knowledge and problem solving abilities improved as a result of attending their Physics classes at PCC.

The nationally administered Force Concept Test and the Mechanics Baseline Test offered the opportunity to compare with national data bases but did not meet the first two criteria for our tests. As a result we decided to design our own test which covered key topics in mechanics. The test is included in Appendix A.

The tests were administered at the beginning of the quarter (pre-test) to 315 students across the district in PHY 101, PHY 201 and PHY 211 classes during Fall 2009 and Winter 2010 quarters. The same test was then administered at the end of the quarter (post test) to a total of 203 students.

The results were significant. The average score on the pre-tests was 2.4 out of 6. This score improved by 60% to 3.8 out of 6 in our post tests. The graph below shows the number of respondents who received a particular score. The pretest shows something close to a normal distribution with most students getting 2 or 3 correct answers and only 1.6% of students getting 6 correct answers (all correct). The post test

data shows a large improvement. The curve is now clearly skewed towards a higher number of correct responses. No students got all the answers wrong in the post test and 7% of students now had all the answers correct.



**Figure 1: Pre and post test results for all Physics classes. The graph shows the percentage of respondents who received a particular score out of six.**

The pre and post test results were also broken down by courses. We have three major series, each of which begins with a course in mechanics (description of motion, forces and Newton’s Laws of Motion, momentum, energy and rotational motion). The PHY 101 series has the lowest level of math requirement with students required only to meet the general education math prerequisite. The PHY 201 series requires algebra and the PHY 211 series requires calculus.

All three classes showed an improvement of 60% to 70% between the pre and post test scores. All graphs show a clear shift to a higher number of correct responses in the post test. The pre and post test averages are shown for all classes on the graphs that follow.

The PHY 101 class showed the largest improvement, with a 70% improvement between the pre and post test scores. A very pleasing result was that, while 26.5% of students had zero or one correct response in the pre-test, there were no students in these two categories in the post test. The most commonly obtained score was a promising 5 out of 6 in the PHY 101 post test.

In the PHY 201 class 63% of students scored zero, one or two in the pretest. This was the weakest performance of all three classes (PHY 101 had 54.8% of students in this category and PHY 211 had 42.4%). However, this figure of 63% did drop dramatically to just 20.6% of students in the post test results. Unfortunately the fraction of PHY 201 students who scored 5 or 6 out of 6 in the post test was not as high as in the other two classes (10.3% versus 40% and 46.2% for PHY 101 and PHY 211 respectively). This may be a result of the fact that the incoming PHY 201 students had weaker preparation but also points to an area that needs improvement.

The PHY 211 class had the highest pre-test average score. In our experience these students are more likely to have had some prior Physics experience which is consistent with their higher pre-test scores. In

spite of this higher starting level these students still managed to improve on average by 60% from pre to post test, giving them the highest post test average score of 4.3 out of 6.

Our test was easy to administer and produced clear and relevant results. This test can be used again periodically in the future to continue to assess our program's performance.

### 2.5.2. Student achievements

One measure of our success as a program is the ability of our students to gain access to scholarships, internships and places in top universities. Here is a sampling of former PCC Physics students and their achievements.

***Oregon NASA Space Grant Scholarship recipients:***

Carolyn, Jennifer, Michelle, Troy, Austin, Nathan, Shelly

***UCORE and other internships:***

Luke, Miranda, Troy, Dorothy, Betty, Warren, Steve, Jennifer, Austin, Chris

We have also had a large number of students transfer to top schools (Examples: Cornell, Harvard) and go on to excellent graduate schools.

### 2.5.3. Future surveys

In order to create a more comprehensive assessment of which institutions and programs our students attend after leaving PCC we plan in the future to survey our students at the end of each series. This will provide us with a better idea of the student population that we are serving. This could impact all areas of our presentation such as what kind of examples we use in different classes and what sort of laboratory experience is most useful for our students. It may also assist us with evolving our Physics Intended Outcomes as we see more clearly what careers our students will be entering in the future.

It also influences how we advise students on career opportunities. Career advice is often an informal part of our experience with our students.

## PHY101 pre and post results

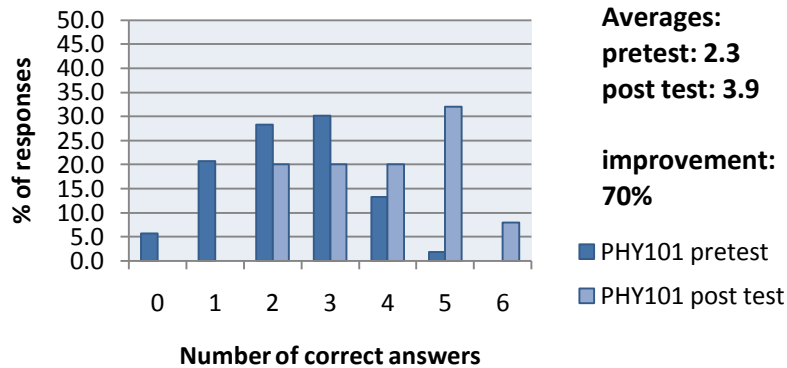


Figure 2: Pre and post test results for PHY 101. The graph shows the percentage of respondents who received a particular score out of six.

## PHY201 pre and post results

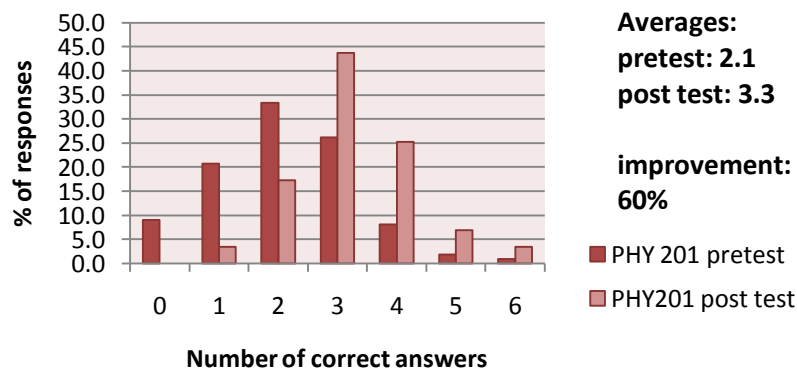


Figure 3: Pre and post test results for PHY 201. The graph shows the percentage of respondents who received a particular score out of six.

## PHY211 pre and post results

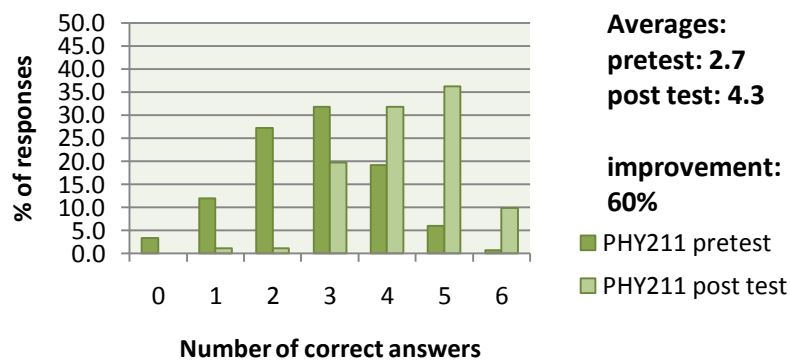


Figure 4: Pre and post test results for PHY 211. The graph shows the percentage of respondents who received a particular score out of six.

## 2.6. Distance Learning

PHY 101 (Conceptual Physics) has now been developed as a Distance Learning course which utilizes an on-campus weekly lab. The PHY 101 course material was originally developed by Vicki Schroeder, and the lecture portion has been adapted for DL delivery by Margie Fyfield. Here are several pieces of valuable information that have been gathered so far from our experience with offering Physics in the DL format:

- Although students initially question the need to come to campus for the lab portion of a DL Physics course, most quickly realize how important it is to understanding the Physics and agree that it is a necessary component of the course. Furthermore, after interacting online, students enjoy meeting each other face-to-face for the labs.
- A few students do drop the course very quickly when they realize that they must come to campus for the lab portion. For this reason, it is very important to inform students via the schedule of classes that the course requires an on-campus lab.
- One advantage the DL format offers over traditional face-to-face Physics lectures is the increased level of student engagement via required online discussions. Whereas in the classroom a student can sit all term and never share, it is fulfilling as an instructor to watch students come alive online and really enjoy the discussions.
- In addition to the traditional on-campus exams, another advantage in the DL format is the online quiz feature. Many of the quizzes are available to be taken as many times as needed to obtain the maximum points available. By the time a student sits down to take an exam on-campus, they have had the opportunity to explore the material to a great extent.
- Because of the combination of both the conceptual and mathematical nature of Physics, explicit online resources with step-by-step solutions to problems are also extremely helpful to students.
- As with all Distance Learning courses, students do need to be self-disciplined in their studies and utilize posted schedules to stay on top of course timelines.
- Developing and managing Distance Learning courses is very time consuming.

An excerpt from an email written to Margie Fyfield from one of her students testifies to the success of the DL format:

"I must say, I thoroughly enjoy the format of this class and the way you are presenting it. I wish every one of my classes was like this class. The online discussions help generate ideas I never would have thought of. The in-class lab helps to cement the homework problems, and the online tabulation of grades helps put my mind at ease as to where I stand. I have learned, and will continue to learn, so much about Physics through this method! Please provide my recommendation for the facilitation of this class to the dean or someone who can make the changes because I feel this format works perfectly with people today. If every one of my classes could be delivered like this, I would have a full schedule of these classes, whether it be math, Physics, science, literature, history, anything!"

Our plans for the future development of Distance Learning Physics classes are as follows:

#### **Academic Year 2010-2011**

Since PCC will be transitioning from Blackboard to a new DL delivery system, Vicki Schroeder will be taking part in the training for the new system as soon as it is selected. Also during this year, we will be researching the possibility of utilizing take-home lab "kits" with DL Physics courses as opposed to the traditional on-campus Physics labs. Since this method has already been successfully implemented in Chemistry, we feel that we should at least explore the possibility and ramifications of implementing it for Physics.

#### **Academic Year 2011-2012**

Contingent on funding for release time or sabbatical, Vicki will be adapting both the PHY and PHY 103 courses for the Distance Learning format using the new delivery system.

#### **Academic Year 2012-2013**

The whole conceptual Physics series (PHY 101, 102, and 103) will be offered in the schedule of classes, making it possible for students to complete the entire series via a Distance Learning format.

After this series has been successfully developed in the DL format, our next undertaking will be to consider a similar development of the Algebra-Based Physics series (PHY 201, 202, & 203).

### 3. Needs of Students and the Community

#### 3.1 Demographics

Community colleges provide a convenient and inexpensive alternative for many students to start their college education, take some classes, or acquire professional skills. The accessibility and flexibility of community colleges are critical for local residents and students. Yet, they are also responsible for the rapidly changing demographics of community colleges. With accommodating admission deadlines and schedules, local community colleges can observe demographic shifts well before they occur at most four year institutions.

Perhaps the most obvious demographic change that we observed at PCC in recent years is the increase in enrollment. In fact, PCC is now serving 13% more students than it did a year ago. The increase in enrollment is not unexpected. The recent economic environment has had a dual effect on PCC enrollment. The sharp drop in major stock market indexes has prompted many families to reconsider the educational path for their children. The decreased wealth has resulted in many students who would normally enter four year colleges as freshmen to start their education at a community college. Thus, PCC instructors are seeing a large influx of students who plan to complete their first two years of classes at PCC and then transfer to another institution to finish their degree. In addition to the wealth effect mentioned above, Oregon community colleges have also observed an influx of students due to high unemployment and general economic slowdown. Lack of employment opportunities has forced many older students to reconsider their career paths and enroll in a community college to either change careers or to acquire additional skills. Many of these students were successfully employed prior to matriculating at PCC.

The two groups of students described above view their education very differently and thus require instructors to adjust their teaching styles accordingly. Most students planning to transfer to another college view their Physics courses as either general science credits necessary to fulfill a requirement or as a theoretic foundation necessary to pursue further study in sciences. Some formerly employed students, on the other hand, view their Physics classes as practical training necessary to obtain employment. While they still seek to have a strong theoretical foundation in Physics, their primary goal is to obtain applied training and skills that employers seek.

The difficult task of providing a strong theoretical foundation while also teaching Physics as an applied science is one faced by all instructors at PCC. To address these issues, instructors select additional chapters from the textbook and provide real-life examples. Additionally, newly redesigned laboratory sessions and modern laboratory equipment allow students to see Physics as an applied science while reinforcing theoretical fundamentals. Sylvania, for example, has had great response from students regarding the new laboratories. These labs teach students not only about Physics, but also about general quantitative and laboratory skills that they will use in other classes and at work. In some cases, students have commented that some of the laboratory equipment that they use during Physics labs is the same equipment that they use at their jobs as engineers.

The Physics department at PCC could still improve its diversity by attracting more female and minority students as the department lacks diversity compared to Portland Community College as a whole. However, this is a problem faced by most quantitative departments such as mathematics and science.

Yet, the Physics department has seen a steady increase in female and minority students in recent years. This improvement is likely a reflection of our program's efforts to increase diversity as well as a general change in society's views.

### 3.2 Community feedback

All institutions of higher learning have a responsibility to provide educational services that are sought by the students and the community alike. This is especially true for community colleges. Compared to most private and public four year universities and colleges, community colleges have a larger number of local students. These students have a better understanding of the local economy and the job market. They often choose a community college in part because all of their needs can be addressed in an effective and cost-efficient manner. Many of these students will remain in the community after completing their education at the community college level and beyond. Thus, it is equally important for the students and the community as a whole that educational services provided by community colleges address the concerns of students and local enterprises such businesses.

Many local firms and businesses have great interest in insuring that community college students are prepared to enter the workforce after graduation. Portland Community College, as well as other community colleges, seek active partnerships with the business community. These partnerships can take many forms and can range from financial support for specific programs to simply providing some insight on the skills and knowledge that they would like to see in their employees. It should also be noted that community colleges generally have a greater number of older students with significant industry experience. Many of these students are employed within their chosen field while attending community college. As a result, these students know what skills they need in the workforce and can be a vital link between the theoretical and practical components of education. Physics is sometimes thought of as a highly theoretical subject. Yet, it is also a subject that has numerous practical applications. While it is important that our Physics students have a solid understanding of the theoretical concepts, we must also realize that most of our graduates will not become theorists. Instead, they will apply their Physics knowledge on the job.

As instructors, we must listen to the concerns of the students and the local community, and tailor the curriculum to address these concerns. Significant growth in the electronics, computer, and semiconductor industries has created much demand for graduates with a solid foundation in Physics and electronics. Many Physics professors have noticed that students are asking questions that relate to these industries since they are either currently employed within these industries or plan to enter these fields after graduation. As a result, instructors now provide more classroom examples that are relevant to these industries. This truly benefits everybody. The students find these examples more interesting and relevant. The businesses can find students who have the knowledge and skills to enter the workforce.

In order to meet the demands of students and employers, the Sylvania Physics department recently restructured its laboratory sessions. A new laboratory manual was written by instructors. The new manual reflects advancements in Physics and technology, as well as teaching methodology. Additionally, much of the old laboratory equipment has been replaced with modern equipment that includes a computer interface. The additional capabilities of the computer interface are vast and allow for greater speed and accuracy. This enables the students to complete the experiments faster and dive deeper into

the analysis. Having the computer interface provides opportunities for analysis that were not previously possible. The equipment allows students to complete their experiments faster and with greater understanding of the subject. Furthermore, the technology used by students during the laboratory is commonly applied in the industry in a variety of fields including electronics, dynamic learning algorithms, and semi-conductors.

In conclusion, the Physics faculty has taken a number of steps in order to address the concerns of students and the community. Indeed, community colleges generally have an advantage in doing so over most 4-year universities. Many of our students are either working while attending college or have prior work experience. Furthermore, most of our students are local residents and plan to work locally after graduation. This establishes a close relationship between students and employers, with both having a strong interest in having PCC graduates complete their education with the skills and training sought by employers. Instructors have changed their lectures to address modern topics in Physics, provide more examples with practical applications, and assign homework and laboratory assignments that will prepare students for life beyond the Physics classroom.

## 4. Faculty

### 4.1 Faculty qualifications and distribution

Currently at PCC, all Physics course offerings are offered at Sylvania, Rock Creek and Cascade Campuses. As shown in Table 4.1, all three campuses employ at least 1 full-time Physics instructor. Sylvania and Rock Creek Campuses each have 2 instructors. The number of full-time Physics faculty, both district-wide and individually at each campus, has not changed during the past decade. Thus, the distribution of full-time Physics instructors evolved in parallel with expansion of Physics offerings at the various campuses and corresponding enrollment rates and SFTE prior to the 1999-2000 academic year.

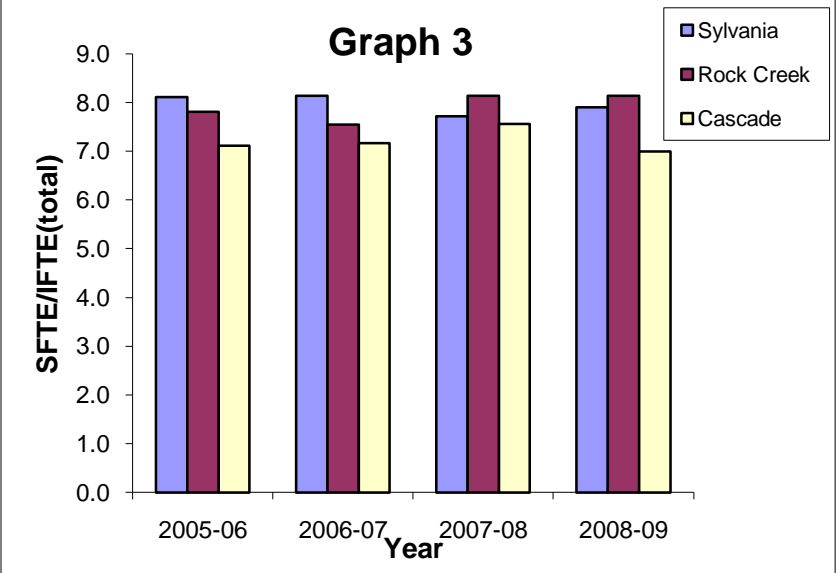
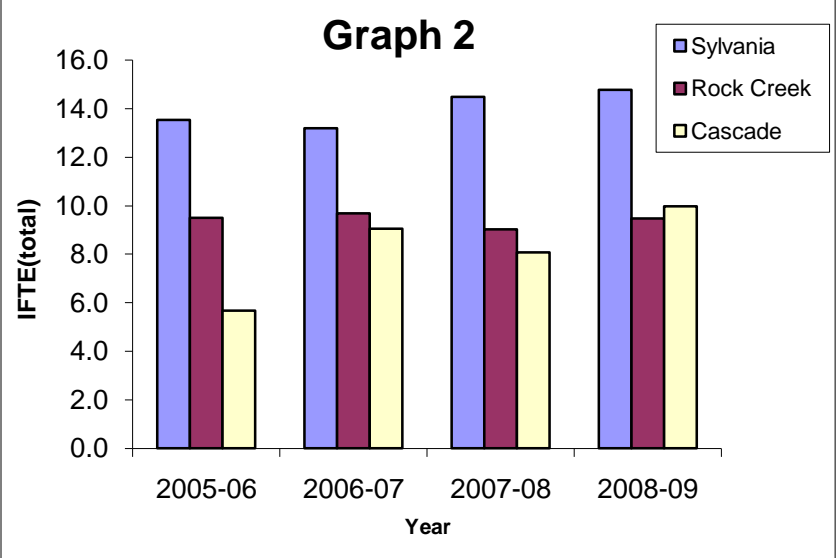
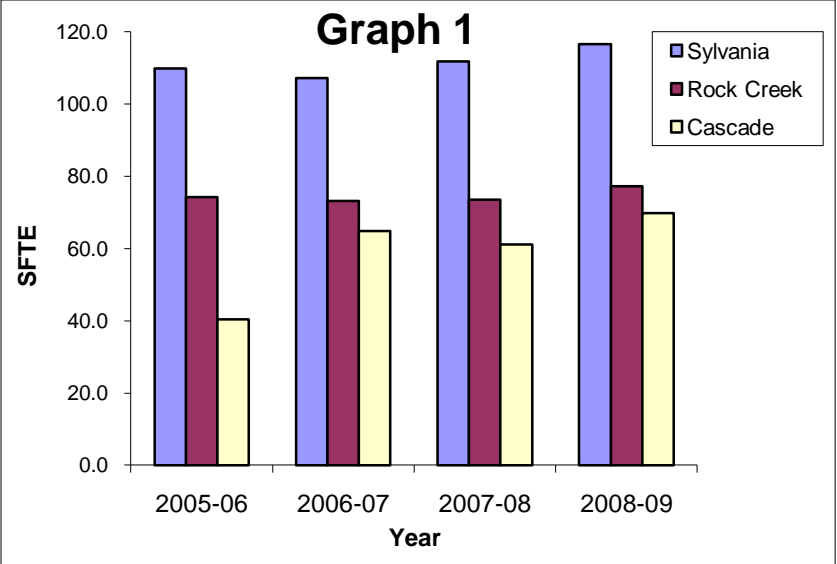
The full-time Physics faculty is comprised of 3 PhDs and 2 Masters Degree recipients, with 2 theoretical physicists and 3 experimentalists. This balance between degree levels and field emphasis has enabled PCC to provide our students diverse perspectives on the field and study of Physics.

**Table 4.1:**

Location	Total FT Faculty	Avg # Years of FT PCC Service	Highest Degree Obtained		
			PhD	MS/MA	Other
Sylvania	2	16	1	1	0
Rock Creek	2	11	1	1	0
Cascade	1(0.7)	12	1	0	0
<b>District-wide</b>	<b>5 (4.7)</b>	<b>14</b>	<b>3</b>	<b>2</b>	<b>0</b>

As Physics enrollment continues to rise, additional full-time instructors are needed to meet the increasing demand. As shown in Graph 1, the total number of Physics SFTEs has consistently increased district-wide since our last Program Review. Both Sylvania and Cascade have experienced large SFTE increases, with Rock Creek enrollments increasing more moderately. Notably, as illustrated in Graph 1, Cascade Campus has seen the most significant growth during this period, comprising roughly 18% of total Physics SFTEs in 2005-2006 compared to 27% during 2008-2009. To reiterate, the enrollment growth at Cascade Campus has occurred during a period where all three campuses have experienced observable growth. Cascade's enormous growth does not merely represent a redistribution of student enrollments across the district.

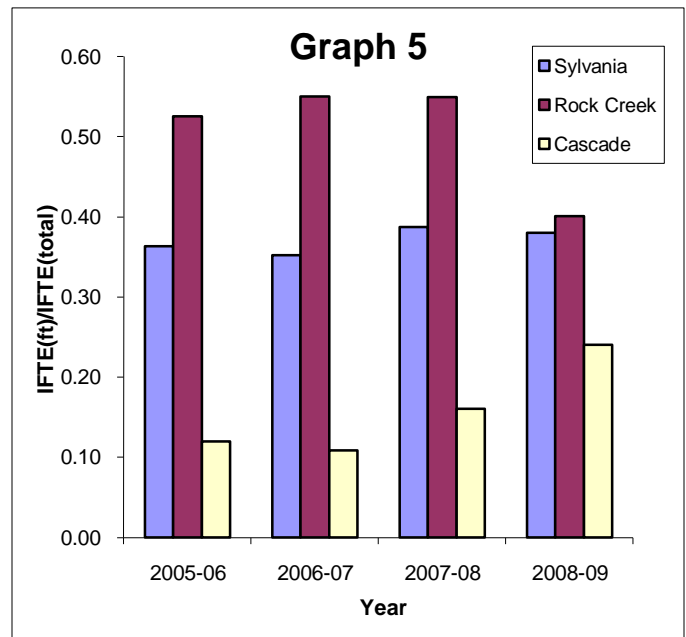
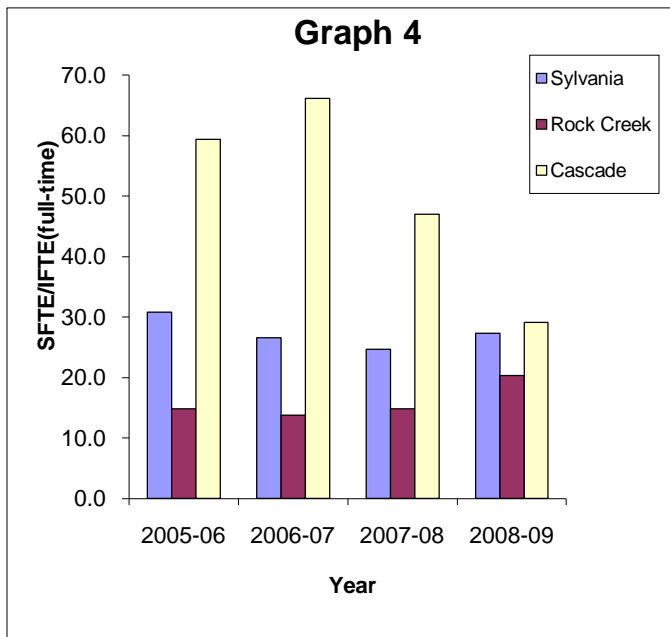
Student enrollment demands for Physics courses have necessitated the offering of additional class sections and hiring of adjunct Physics instructors to teach these sections. Observing Graphs 1 and 2 together, the Physics SFTE growth trends have been accommodated by concomitant increases IFTEs both campus specific and district-wide. This increase in IFTE has occurred through hiring of adjunct faculty to teach the added Physics sections necessitated by student enrollment increases. Since the last Program Review, the ratio of SFTE to total IFTE across all campuses has remained relatively constant; roughly 7.5 to 1 (see Graph 3).



## 4.2 Expansion of Physics Faculty

During the period since the last Program Review, given the observed student enrollment growth trends and inclusion of Physics offerings at Southeast Center, the Physics SACC currently anticipates the immediate need for the hiring of a minimum of 2 new full-time Physics faculty. The reasoning behind this conclusion is two-fold:

1. **Growth at Cascade Campus:** As described above, Cascade Campus Physics SFTE have continued to grow at a significantly faster level than Sylvania and Rock Creek. ***The allocation of a single faculty member at Cascade is no longer adequate for the current and future student demand.*** As illustrated in Graph 4, the SFTE to full-time IFTE ratio is substantially higher at Cascade than Sylvania or Rock Creek. Graph 5 illustrates that the ratio of full-time to total IFTE is, and has been, significantly lower at Cascade than the other campuses, residing in the 10 to 20% range. The Physics SACC concludes that this ratio should be approximately 50% for all campuses, both for continuity of instruction and to facilitate the management of adjunct faculty. *In addition, this has been considered a stated goal by the Faculty Federation in past years.* A key goal for the Physics SACC is to maintain consistent instruction between the various campuses, including the SFTE:full-time IFTE and full-time IFTE: total IFTE ratios.
2. **Addition of Physics offerings at Southeast Center:** An exciting goal of the Physics SACC is to start offering Physics courses at SE Center beginning in the 2011-2012 academic year. Bringing Physics to ***SE Center will require the presence of a full-time instructor on that campus*** to organize and equip the new Physics laboratory. In addition, this faculty member will be instrumental in nurturing the growth and development of the new Physics department, as well as overseeing the hiring of future adjunct instructors.



### 4.3 Faculty turnover and anticipated changes

As indicated above, the number of full-time Physics faculty has not changed in over a decade. Moreover, there has been no full-time faculty turnover. We have been extremely fortunate to have retained all of these competent physicists.

Given the economic climate of the past several years, the adjunct Physics faculty employed by PCC has remained relatively stable with minimal turnover. Over 80% of the current adjunct Physics instructors have been with PCC for at least 2 years, many have been teaching classes for over 5 years. When our adjunct instructors find more permanent employment, it has proven relatively difficult to identify competent, dedicated, student-centered replacements.

Over the past few years, PCC has been extremely fortunate to have identified and hired a number of extremely talented Physics educators. These instructors receive great student evaluations and contribute prominently in the activities of the Physics departments on their respective campuses. The Physics SACC is fully supportive of our valuable part-time faculty and their professional development, and would like to see these individuals have the opportunity to compete for full-time employment at PCC. Moreover, as the economic climate improves, academic and high-tech employment will inevitably become more available. Undoubtedly, PCC will lose many of our prized adjuncts to other academic institutions and/or the private sector. This loss will ultimately be our students' loss.

### 4.4 Adjunct Faculty

The Physics departments on all campuses rely heavily on the time and efforts of our adjunct instructors. As illustrated in Graph 5, the Physics adjunct faculty have consistently accounted for 45% (Rock Creek) to 85% (Cascade) of the total Physics IFTE depending on the campus. Our adjunct faculty is highly dedicated to their students. They have the minimum education level of a Masters Degree in Physics, Engineering or related field. Many are former private sector engineers and scientists, and bring a wealth of outside the classroom perspective to our students. In summary, our current adjunct faculty is educationally and professionally comparable to their full-time colleagues.

## 4.5 Faculty Composition

As illustrated in Tables 4.1 and 4.2, the full-time Physics faculty represents a diverse and balanced collection of academically successful professionals. The district-wide female to male ratio is 2:3.

Although 80% of the faculty composition is technically “white”, 50% of those individuals’ country of origin is outside the USA. This distribution reflects a unique academic and cultural diversity that serves our students well.

**Table 4.2:**

Location	Gender		Ethnicity			Country of Origin	
	Male	Female	White	Asian	Other	USA	Other
Sylvania	2	0	2	0	0	1	1
Rock Creek	0	2	2	0	0	1	1
Cascade	1	0	0	1	0	1	0
<b><i>District-wide</i></b>	<b>3</b>	<b>2</b>	<b>4</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>2</b>

## 5. Facilities

### 5.1. Classroom, laboratory and office space

The lecture rooms and lab space required for the Physics program are integrally linked to the educational philosophy regarding class size and growth in both the Physics program and other sciences. Class size has historically been radically different between the Sylvania Campus and Rock Creek and Cascade campuses. Physics classes at Sylvania are regularly offered for a maximum of 48 students, whereas no Physics classes are offered at Rock Creek or Cascade with more than 24 students.

In spite of the fact that in previous Program Reviews and in recommendations to the Administration from the Physics SACC that Physics classes should be no larger than 24, attempts by the Sylvania Administration to comply with this recommendation have failed. This large class size puts additional stress on classroom and lab space at Sylvania, and provides a disadvantage to students in Physics courses at Sylvania through overcrowding. This overcrowding is made more severe when the growth of all other sciences utilizing the facilities forces the use of the Physics lab at Sylvania for other programs for both lecture and lab.

A prime consideration for facilities in this Program Review is the expected expansion of the Physics program to the Southeast Campus. Plans are being drawn up now for the Library/Science Building to be built and occupied in the next two years. The plans call for a Physics lab and a Science lecture room. Physics would occupy one of the four planned labs, the other being utilized by Chemistry and Biology (2 labs). However, the Physics SACC recommends that this lab arrangement is not sufficient to accommodate growth in science in the future. Therefore, the four science labs and one science classroom at the Southeast Campus are insufficient to accommodate this future growth.

While one 12 station Physics lab is sufficient to accommodate a robust Physics program at Southeast, additional science labs are needed. There needs to be a Physical Science/Astronomy lab at Southeast campus as well as an additional Chemistry lab for a total of six science labs. Having a Geology/Physical Science offering at Southeast would open up classroom and lab space at Sylvania for Physics. Our recommendation is that no classes other than Physics be conducted in the Sylvania Physics lab, so that Physics instructors have time to set up, dismantle and organize equipment, as well as utilize the lab space for research and development of new labs.

The educational philosophy at the new Physics program at Southeast is also an important factor in determination of future facility needs. The educational plan for Southeast Physics is in line with that of the majority of classes at the Rock Creek and Cascade campuses. That is,

1. Physics class will be ***no larger than 24 students.***
2. emphasis will be on maximum utilization of full-time faculty, and
3. laboratory classes will be taught by the ***same*** instructor as the lecture.

This educational philosophy will put Sylvania at an increasing minority in the methods of delivery of Physics education. If Sylvania finally begins to adapt to the educational philosophy of the other campuses, additional stress will be placed on Sylvania classroom space. As Physics classes at Sylvania are decreased in size, considerable extra classroom space and faculty will be required at Sylvania.

More faculty at Sylvania requires more office space, as the office space is presently horribly inadequate. Over twenty Adjunct faculty share a space large enough for normal cubicles for two faculty! ***Office space is critically needed*** since over the last twenty years no full-time Physical Science faculty have been added to the Sylvania Campus, while approximately 20 adjunct faculty are currently teaching. These new adjunct faculty have received no additional office space.

## 5.2. Facilities summary by campus

### Sylvania Campus:

- A. Lab space is adequate to accommodate current enrollment. (no growth)
- B. Additional classroom space (25%) required to accommodate smaller class sizes.
- C. Additional faculty office space is urgently required, even if no additional faculty are hired.

### Rock Creek Campus:

- A. Current lab and classroom space is adequate to accommodate current enrollment.
- B. A limited amount of growth can be accommodated.

### Cascade Campus

- A. Current lab and classroom space is adequate to accommodate current enrollment.
- B. A limited amount of growth can be accommodated.

### Southeast Campus:

- A. One Physics lab with 12 stations for 2 students each.
- B. Complete set of Physics lab equipment for 12 stations – approximate cost of \$100,000.
- C. One science lecture room is not sufficient for use by all science classes. A complete Physics offering would utilize one classroom 50% of the time.
- D. Adequate office space for all science faculty with room for future expansion.

## 6. Recommendations for Improvement

### 6.1. Summary of Strengths

- A key strength of Physics at PCC is the small size of **most** of our courses. This is an advantage for students in that it is a primary factor in both student success and retention. Class limits of 24 allow for the pairing of lecture and lab sections under a single instructor, which follows the recommendation of the American Association of Physics Teachers (AAPT). It would be best if **all** Physics courses at PCC were offered in this manner.
- The lab equipment and facilities at Cascade and Sylvania have vastly improved since our last Program Review, and both now incorporate 12 stations with 2 students per station. The quality and amounts of lab equipment at all 3 campuses are being continually improved, as new equipment and technology become available.
- Physics offerings at PCC have expanded to include an entire Conceptual Physics series (PHY 101, 102 & 103).
- PHY 101 is now offered in a Distance Learning format, and PHY 102 & 103 will also be adapted for this format in the near future.
- We are fortunate to have a strong, core group of dedicated, part-time instructors who have been with us for many years and continue to improve the quality of Physics instruction at PCC.
- Physics tutoring is now regularly available at all 3 campuses.

## 6.2. Areas in Need of Improvement

In order of importance, the foremost needs of the Discipline of Physics at PCC are as follows:

- Clearly, in light of the tremendous growth of the Physics department at Cascade, an additional full-time Physics instructor position is desperately needed at that campus.
- Class size limits at the Sylvania campus should be reduced to 24 students in order to improve student success and retention, in order to be in compliance with the recommendations of the AAPT, and to equalize the quality of Physics instruction at all PCC campuses by having lecture and laboratory courses taught by the *same* instructor.
- It is the view of the Physics SACC that the addition of a full-time Physics instructor position at the Southeast Campus should precede the planned growth and development of Physics at that campus.

## Appendix A: Mechanics Assessment Test

Please circle the class you are taking and then answer the 6 questions below by circling the letter you think best answers each question.

1. A ball is thrown upward at 30 m/s. If we ignore air drag and assume gravity is  $10 \text{ m/s}^2$ , the ball will be in the air for:
  - (a) 3 seconds
  - (b) 6 seconds
  - (c) 10 seconds
  - (d) 12 seconds
2. Ball A is rolled off the edge of the table while a second ball, Ball B, is simultaneously dropped from the height of the table. Ignore air drag.
  - (a) Ball A hits the ground first.
  - (b) Ball B hits the ground first.
  - (c) Both ball hit the ground at the same time.
3. An object in outer space is accelerated by a 50N force. If a second 50N force acting in the *opposite* direction is then suddenly applied to the object, the object:
  - (a) rapidly stops.
  - (b) gradually slows down and then stops.
  - (c) continues accelerating.
  - (d) continues moving at the speed it was going when the second force was applied.
  - (e) none of the above.
4. Two train coaches collide. Coach A is 2000 kg and is travelling at 5 m/s and collides with Coach B which is 3000 kg and is at rest. If the two coaches stick together after the collision, what is their combined final speed?
  - (a) 1 m/s
  - (b) 2 m/s
  - (c) 3 m/s
  - (d) 5 m/s
  - (e) 10 m/s
5. A 2 kg ball is lifted off the ground so that it gains 100J of gravitational potential energy. If the ball is dropped, what is the speed of the ball when it hits the ground? Ignore air drag.
  - (a) 2 m/s
  - (b) 4 m/s
  - (c) 10 m/s
  - (d) 20 m/s
6. A hammer is easier to balance upright on your hand when:
  - (a) the hammer head is farthest from your hand.
  - (b) the hammer head is nearest to your hand.
  - (c) makes no difference, same either way.