Guidelines for
Two-Year College Physics Programs

AAPT American Association of Physics Teachers

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AAPT Guidelines for Two-Year College Physics Programs

Table of Contents

AAPT Guidelines for Two-Year College Physics Programs

The American Association of Physics Teachers (AAPT) is actively committed to the support of high-quality physics education at the two-year college level. The following professional guidelines have been prepared to serve as:

- a guide for institutional self-studies and program reviews;
- a resource for regional accrediting groups when revising self-study guidelines and conducting visitations for assessment of programs; and
- a guide to assist two-year college presidents, deans, and physics professors in developing reasonable standards to assure quality physics instruction in two-year college physics departments.

Most of these guidelines were developed by a task force concerned with the quality of instruction in two-year colleges and were published in 1990 after a preliminary draft was circulated widely within the physics-teaching profession. A team of editors revised the guidelines during 2000 and 2001 at the request of the AAPT Committee on Physics in Two-Year Colleges. The team of editors solicited the input of the two-year college physics community electronically before beginning the revision and publicized the proposed revisions through sessions at national AAPT meetings and a newsletter mailed to two-year colleges nationwide before the revised guidelines were approved by the Committee on Physics in Two-Year Colleges. (See p. 2 for a list of the editors and the 2001 Committee members.) AAPT adopted these guidelines to serve as official standards by which interested persons may assess physics instruction in two-year colleges.

The task force on physics in the two-year colleges appreciated the help and direction of *Guidelines for Chemistry and Chemical Technology Programs in the Two-Year Colleges* by the American Chemical Society (ACS) in developing the 1990 guidelines. Many two-year colleges have divisions or departments that contain both subjects. Consistency, when possible, should make for easier implementation.

Preamble

The quality of a two-year physics program is determined in part by the quality of the preparation and the overall workloads of its faculty, as well as the adequacies of departments' budgets, facilities, and support services.

If the college administration or its Board of Trustees has a narrow view of physics, or if there is not an awareness of the need for a broadly prepared physics faculty who are active as professional physicists, the physics program cannot remain strong, regardless of its other assets. 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.

How to Use These Guidelines

Aims of Guidelines

The guidelines are meant to help two-year institutions provide physics students with the best possible education in the fundamental areas of physics and its relation to other disciplines and to society. To achieve this goal, general curricular guidelines, rather than specific curricular content, are defined. Implementing these guidelines can help ensure that the physics course offerings and programs of an institution:

- are consistent with the mission of the institution;
- meet the needs of entering students with diverse backgrounds and abilities;
- utilize and enhance the strengths of the institution and the community;
- articulate with the physics programs at those four-year colleges to which most students transfer;
- are comparable to programs of recognized quality;
- meet local industries' needs for technical personnel;
- augment the continuing education and other local community physics education needs;
- maximize the learning of physics in the classroom; and
- improve the appreciation of physics by students and within the surrounding community.

Types of Institutions

The guidelines are designed to accommodate all those postsecondary institutions generally referred to as two-year, associate-degree-granting colleges. They attempt to take into account the great diversity of these institutions and their programs, the great heterogeneity of the student body, the diverse curriculum, and other characteristics unique to these institutions. The guidelines describe standards for a comprehensive two-year college physics program. Institutions that do not have a comprehensive mission may find that some of these standards are not applicable to their mission. In such cases, only those standards applicable to their mission should be used in the review process. Institutions that have low enrollments may find it difficult to achieve some of these standards. In such cases, the guidelines may help give a direction to future program development and growth.

Use of Guidelines

These guidelines are intended to improve programs rather than to approve or disapprove them. Institutions should carefully consider their rationale for deviation from a standard and provide explanation in a program assessment document. External consultants can evaluate these self-study reports to determine if the guidelines are being followed as closely as is feasible.

Starting a Physics Program Assessment at Two-Year Colleges

Today, two-year colleges (public or private) may be called community, technical, or junior colleges depending upon the primary focus of their academic mission. The American Association of Community Colleges (AACC) recognizes them as regionally accredited, postsecondary institutions that offer an associate degree.[1] Appendix A outlines the development of the two-year college in the United States.

The majority of these institutions today are best described as community colleges, even though some still retain the title "junior" college. Therefore, these guidelines establish standards for a two-year college physics/astronomy program that should meet the needs of the comprehensive community college as it enters the 21st century. Appendix B presents a description of the mission of a typical community college.

When using these guidelines as the basis for a program assessment, physics departments should not only clarify for the reader the educational mission of their particular two-year institution, but also describe how their college functions within the state's higher education system. This would be most helpful for readers unfamiliar with the role of two-year colleges within the higher education system of a particular state. For certain types of program assessments, a discussion of the college's funding sources and the internal budgeting process of the college may also be appropriate. A description of the administrative structure of the college and of how the physics faculty function as an independent group within this structure can point out the unique strengths of the more interdisciplinary approach to administration used in most two-year colleges. In addition, the physics program assessment should outline the decision-making processes used within the division/department in which physics faculty operate as a unit, as well as those that are employed within the college as a whole.

Characterized by an egalitarian "open-door" admissions policy that does not necessarily include "open-program" admissions, the community college is faced with the challenge of meeting the educational needs of a growing and increasingly diverse student population. Recent data[2] show that two-year colleges serve a credit enrollment population that encompasses:

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[1] American Association of Community Colleges, "Constitution of the American Association of Community Colleges," *AACC Membership Directory 2001* (Community College Press, Washington, DC, 2001), p. 203.

[2] American Association of Community Colleges, "National Community College Snapshot." http://www.aacc.nche.edu/allaboutcc/snapshot.html. April 29, 1999.

- 46% of all first-time freshmen;
- 44% of all U.S. undergraduates;
- 46% of all black students in higher education;
- 55% of all Hispanic students in higher education;
- 46% of all Asian/Pacific Islander students in higher education; and
- 55% of all American Indian students in higher education.

More than 5.4 million learners enroll for credit in community, technical, or junior colleges each year; the majority (64%) are part-time students, compared to a part-time student enrollment of 40% in 1970. This shift in attendance pattern is largely due to the increasing number of adults, 25 years and older, taking advantage of postsecondary educational opportunities. The average age of students at public community colleges is 29. The growing participation of minorities, women, and new immigrants in two-year college education has also contributed to the large number of part-time students. Women account for 58% of community college credit enrollments, as compared to 47% in 1976.

A recent study by the American Institute of Physics[3] found that the vast majority (88%) of students enrolled at a two-year college are at a campus where physics is offered. One-hundred and twenty thousand students take some form of physics at a two-year college nationally each year; 33,000 of these students take calculus-based physics or other advanced courses, 40,000 take algebra/trigonometry-based physics, 19,000 take conceptual physics, and 11,000 take technical/applied physics. Sixty-nine percent of the students taking physics at two-year colleges are male, compared to around 75% of students taking introductory physics at four-year schools. Seventy-seven percent of the students taking physics at two-year colleges are white or Asian-American, while 15% are black, Hispanic-American, American Indian, or classify themselves as "other"; and 8% are non-U.S. citizens. For comparison, 83% of the undergraduate students taking physics at four-year colleges and universities are white or Asian-American, while 9% are black, Hispanic-American, American Indian, or classify themselves as "other"; and 8% are non-U.S. citizens. The number and types of students taking physics at each two-year college campus vary greatly, and a physics department embarking upon an assessment of its program would be well advised to make use of its institutional database to determine a profile of the students it serves. The inclusion of statistics regarding what students do after completion of their physics course(s) or after graduation would assist the reader in formulating a clear picture of the physics student population.

The program assessment should also clearly state the role that physics plays within the educational mission of the community college. This role is delineated by both the educational goals of the surrounding community and those of the students enrolling in the various courses offered by the physics department. Attempts to ascertain the educational goals of two-year college students, both at the state and national levels, have not always yielded consistent results, which is not surprising when one considers the wide diversity of two-year college student populations within a state or across the nation. However, the following student goals frequently appear in many studies:

- to prepare for transfer to a four-year college or 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.

When outlining the courses offered that enable students to meet their various academic goals, the department should comment upon how their courses are designed, scheduled, and conducted to meet the needs of different student groups. For example, occupational-technical students prefer a more practical, hands-on approach to physics; they want to see how physics is applied within their technical field of study. These preferences call for a physics course very different from the one that is typically presented to pre-engineering students. Other information that would prove helpful to readers unfamiliar with the role of physics within a two-year college includes the:

- availability of honors courses and opportunities for independent study within the physics program;
- means used for identifying and addressing students' "readiness" for entrance into physics courses;
- instructional format used to identify and address students' misconceptions concerning physics;
- ways in which computers and other technology are integrated into the instructional program;
- use and effectiveness of outreach programs to local high schools and businesses and industry in the community;
- ways in which physics works with other departments within the college to provide specialized courses such as technical physics; and
- details of articulation programs with science and engineering departments of four-year transfer institutions.

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[3] Michael Neuschatz, et al., *Physics in the Two-Year Colleges* (American Institute of Physics, College Park, MD, 1998), pp. 7–15.

Curriculum Guidelines

C-1

Course offerings should be consistent with the needs of the population that the college serves.

Courses generally offered by physics departments fall into six categories:

1. **Physics Courses for Nonscience Majors**
   Students in many majors such as business, education, and the liberal arts often are required to take a science course for a degree, and these students can benefit greatly from a nonmathematical physics course. These courses are sometimes called "physics" and sometimes called "physical science." The physics component in these courses would generally be conceptual.

2. **Introductory Astronomy**
   Most of these courses are designed for the general education requirement and are descriptive. In some cases where special programs, equipment, and/or facilities are available, specialized technical courses may be offered.

3. **One-Year College Physics, Algebra/Trigonometry-Based Transfer Courses**
   Most two-year colleges offer these transfer courses for students in biology, medical fields, and other professional programs.

4. **University Physics and Other Calculus-Based Transfer Courses**
   Most two-year colleges offer a two-semester sequence for students planning to enter engineering, computer science, physical sciences, and other programs with such a requirement. Some schools also offer modern physics, engineering statics, and engineering dynamics. In some states, a second two-semester calculus-based transfer sequence is offered; this sequence is designed particularly for students planning to pursue careers in medicine.

5. **Service Courses for Vocational Programs**
   The features that most often typify these courses are those that are generally descriptive, with only limited use of algebra. The ideas studied relate directly to the program in which the student is enrolled.

6. **Service Courses for Technical Programs**
   Physics courses for technical students vary widely from one college to another. Some technical students must take the general college transfer-level physics class, while others offer "tech physics" course(s) or even an entire sequence. The mathematical level of the technical physics student also varies widely from special "tech math" courses emphasizing applications to a requirement for calculus.

C-2

A variety of activities that actively engage the student must be included in any physics course.

Students need to be active participants in the teaching/learning process to help them understand the basic concepts and their implications. Activities should be targeted to the goals of the student and the course. A variety of classroom activities and laboratory experiences are all essential to maximize student learning.

Instructors should not be limited by the fact that some class time is designated as "lecture" in the timetable. 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.

The laboratory component is especially important for any physics course. Well-designed, open-ended experiments expose the students to the experimental basis of physics and combine many different skills and concepts.

C-3

The objectives of a course should be clearly articulated, and the course should be assessed regularly by the instructor in light of students' attainment of the course's objectives.

With the focus in program review efforts on outcomes-based or objectives-based assessment, programs and instructors are well served if courses have well-defined objectives. These objectives should be used to guide student advisement and curricular development within the course. Among these objectives should be the development of quantitative reasoning skills, problem-solving abilities, and qualitative reasoning skills.

C-4

When designing a physics course, the department must ensure that the content is consistent with the needs of the students.

Physics often serves as a support course for students studying in another vocational/technical or transfer program. Periodic feedback to the physics department from other programs is necessary to know how successfully the needs of the students are being met.

C-5

The mathematical and conceptual level of any physics course must be consistent with the abilities of the students in that course.

Pre-tests can help the instructor determine the entry skills and weaknesses of the students. In the latter case, strategies must be devised to correct the noted deficiencies. Care must be taken that evaluations of quantitative reasoning skills, qualitative reasoning skills, and problem-solving abilities are separated in such evaluations. *Development* or *refinement* of problem-solving abilities and qualitative reasoning skills ought to be among the primary goals of most physics courses. Some students may have weaknesses in reading or math; these weaknesses can be addressed best when the student takes or retakes a course in the appropriate department.

C-6

Knowledge of the students' preconceptions of physical concepts is essential when developing instructional strategies.

Students do not enter a physics course as "empty vessels." Instead, without exception, they have preconceptions of what the principles of physics are and what they imply. These student-held ideas are often quite different from what will be taught subsequently in the course. Research has shown that these preexisting ideas are very tightly held and are often unchanged after successfully completing a conventional physics course. These preconceptions must be carefully and specifically addressed if they are to be significantly modified. Thus, a variety of experiences must be developed to expose and remedy student misconceptions.

C-7

Those involved in tutoring and counseling ought to be aware of the goals of the physics courses.

To give appropriate advice on courses or to effectively help students encountering difficulty in a physics course, those responsible for such activities must be aware of the goals and expectations of the college's physics courses.

C-8

Insofar as possible, physics departments should evaluate and implement available technologies that help students learn.

Students enrolled in two-year colleges have a wide range of abilities. Existing and new technologies may provide valuable tools for overcoming the problem of the range of student abilities and experiences. Instructors should not be expected to put in overtime to evaluate and implement existing and new technologies. Evaluation of existing and new technologies must be an ongoing process and should be considered in the instructor's workload. The college should provide adequate technical support personnel to help in this process. The evaluation and implementation of different technologies is costly, and the college should provide financial support. The college can also provide release time and secretarial resources to instructors working on writing grant proposals to find other sources of funding.

C-9

Instructors should be encouraged to attend professional meetings and read publications dedicated to physics teaching.

The primary role of two-year college instructors is teaching. Continual improvement of instruction ought to be one of the most important goals. This can be accomplished by trying new ideas and considering the implications of both physics education research and the experiences of other instructors in similar situations. The college should provide support for instructors to attend professional meetings and to read publications dedicated to physics teaching because these activities will enable them to make better informed decisions when modifying their teaching.

C-10

Instructors should be encouraged to document and share classroom experiences and pedagogical research results, which may have implications beyond the local campus.

Results of a physics teacher's activities should be shared at local, regional, or national meetings and published if possible. (AAPT offers formats for sharing activities both at meetings and through its journals and the newsletters of local sections.) Instructors in similar situations at other colleges can benefit from knowledge of an instructor's successes and failures.

C-11

Opportunities should be provided to allow for underprepared students to gain confidence and experience necessary to be successful in a conventional physics course.

Science illiteracy is a national problem. Two-year colleges have a high percentage of students whose preparation and experiences in math and science are very limited. If those students are to succeed in physics courses, they must first develop the necessary conceptual underpinnings.

C-12

Instructors teaching interdisciplinary courses as part of a multidisciplinary team should spend the necessary time working with other members of the team to ensure that the material covered and the teaching strategies employed by different instructors fit well together. This additional time for meeting with each other to integrate different subjects and styles must be taken into account when determining instructor workload and compensation.

Interdisciplinary courses can be beneficial to students when done well, provided the challenges to doing them well can be overcome. There continue to be efforts to teach courses combining physics and mathematics or physics and other natural sciences. Many believe a curriculum that integrates topics from science and other disciplines taught by a multidisciplinary team is an appropriate vehicle to deliver the content in context for suitable audiences. It is important that the relationship between the various subjects being taught together and the teaching strategies of each instructor are clear to all instructors involved in the course.

C-13

“Stacking” different courses entirely into the same class time with the same instructor has no benefit to the students and should be avoided.

The stacking of different courses into the same class time with the same instructor is very different from an interdisciplinary course. Stacking is used as a money-saving strategy at some institutions where, for example, an algebra-based physics course and a calculus-based physics course covering similar topics are taught entirely during the same class time by the same instructor to different groups of students. Stacking refers to the practice of having the different courses meet simultaneously for <u>all</u> class meetings.

Laboratory Guidelines

L-1

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.

Many institutions have switched to an integrated lecture-lab format where a class of students meets without lecture and lab times clearly defined, and the instructor decides how students will use class time. This format can be successful in improving student learning. The instructor should use a similar portion of time on laboratory activity as in a course with separate laboratory meeting, although that time may be allotted in different blocks. For example, the instructor may have three short lab activities in a week instead of one long one, or the instructor may choose to have a very long lab project one week, but no lab the week before as material necessary to complete the project is covered.

Every physics course should include a laboratory experience. This includes such courses as Physics for General Education, Physical Science, and Physics for Nurses. Laboratories are especially important in vocational and technical physics courses where students want less theory and more practical applications. Science major physics labs need an extra hour because they should be expected to set up the lab equipment and to carry out more extensive data analyses.

L-2

Laboratory experiences should extend beyond the completion of a recipe of prescribed activities.

It is not always possible to design completely open-ended lab activities in the true nature of science, but students should not complete physics labs believing that all data are perfect and that conclusions are absolute.

Activities should include independent data acquisition, numerical and/or graphical analysis, appreciation of experimental limitations, pertinent inferences, and a written report of the experiment. Often the limitation of shorter laboratory times encourages the use of “cookbook” activities.

There are many excellent packages of laboratory activities that make use of computers and sensors to take data and make graphs and tables, freeing the student’s mind to concentrate on how the experimental results agree with the student’s expectations. These activities (and similar ones written by individual instructors), which focus on confronting student misconceptions instead of teaching laboratory methods and techniques, can greatly enhance student understanding of physics concepts when used as part of the lab experience in a physics course.

L-3

Laboratory sessions should be completely under the guidance of a qualified physics teacher.

The laboratory experience is no less important than any other portion of a physics class. Supervision of lab sessions should not be delegated to student assistants, lab technicians, or unqualified teachers from other departments.

L-4

Adequate equipment for each experiment should be available to enable groups of two or three students to share one entire set of equipment.

Most introductory laboratory activities are not elaborate enough to fully involve more than two or three students. Extra students often become passive spectators watching a demonstration of the activity.

L-5

The laboratory environment and experimental equipment should conform to existing building safety and fire codes.

L-6

To assure student safety, the lab instructor should not be expected to monitor more than 24 students in one lab section.

The number of students in a physics class depends as much on facilities and safety as on the workload of the teacher. A typical two-year college physics class should have an absolute limit that is determined by the number of laboratory stations and the design of the room. Other limiting factors for the number of students in a laboratory class are the need for pedagogically effective supervision of the students and the need to ensure the safety of all experimental procedures.

L-7

In computing physics faculty workload, one hour of laboratory supervision should be considered to be at least equivalent to one hour of lecture responsibility.

AAPT has taken note that it has been common practice for some administrators to use a weighting factor of less than one in computing the contact hours in

laboratory instruction. This practice is in direct conflict with the recognized demands, both physical and emotional, that are placed on an instructor in the supervision of extended laboratory sessions. From the instructor's point of view, the amount of effort required to sustain the expected level of student involvement throughout a full laboratory session warrants a weighting at least equal to the time spent in the lecture mode of instruction. Weighting factors less than one de-emphasize the laboratory aspect of the discipline, even though physics is a laboratory science. Unless laboratory contact time receives workload recognition equal to that accorded to lecture contact time, there will be a continuing erosion in the quality and quantity of student laboratory experience in the experimental sciences.

L-8

Adequate support personnel should be provided so the laboratory instructor can focus on teaching and learning.

Each weekly lab session requires tasks in addition to pedagogical responsibilities. These include distribution and storage of weekly lab equipment, maintenance of equipment, computer maintenance and upgrades, software installation, safety inspections, inventory updates, and ordering or designing new equipment. Larger physics departments (more than 20 weekly lab hours) should include a full-time lab technician. Smaller departments should hire part-time technicians or award released time to physics faculty members.

Personnel Guidelines

P-1

The minimum academic preparation for full-time faculty teaching academic transfer courses is a master's degree in physics. For vocational/technical courses, the full-time faculty should have a master's degree in physics or in a related field.

The question of faculty credentials must be answered in terms of local contemporary standards and the courses they are expected to instruct. Many two-year colleges utilize adjunct (sometimes called part-time) instructors. These instructors should meet the same guidelines as full-time faculty. The full-time faculty should have major input into the selection of adjunct instructors.

P-2

Each two-year college and its physics department should have an active program to encourage equal opportunity in employment and student activity for members of underrepresented groups.

P-3

The required teaching load of any physics or astronomy teacher should not exceed:

a. Fifteen contact hours per week or
b. Twenty-four average student contacts per hour.

One contact hour of required teaching load should be subtracted for every three hours per week (averaged over a term) of special assignments.

Definitions

Contact hour: A contact hour is 50 minutes of time during which the teacher is required to be present in a classroom or laboratory with a group of students.

Average student contacts per hour: The total number of students contacted in class per week divided by the number of contact hours. (See Table I.)

Special assignments: Assignments beyond classroom and laboratory teaching responsibilities. In physics and astronomy, such assignments include subject matter and instructional research, advising students, curriculum development, special committees, administrative duties, maintaining an equipment inventory, equipment repair and design, and weekly lab setup and teardown.

When these limits are exceeded, the quality of the physics or astronomy program can be maintained only if the instructor works more than the 40–45 hours traditionally considered full-time and sacrifices personal time. No instructor should be compelled to exceed these limits.

Table I. Example of calculating student contacts per hour.

Load	Contact Hours		Students in Class		Total
Lecture	3	×	32	=	96
Lecture	3	×	24	=	72
Lecture	3	×	20	=	60
Laboratory	3	×	20	=	60
Laboratory	3	×	18	=	54
Total	**15**				**342**

342 / 15 = 22.8 average contacts per hour

P-4

The integrity of the physics program should not be jeopardized by the overuse of adjunct or part-time instructors. Adjunct faculty should not be used in more than 25% of the class sections offered each year.

Most two-year colleges use part-time faculty to supplement their teaching staff. Part-time faculty should be used to teach specialized classes for which they are uniquely qualified and to teach regular physics classes only if there is no ongoing need for additional full-time personnel. Part-time instructors should not be used as a money-saving strategy.

All part-time faculty must be well qualified and prepared to teach the courses they are assigned. Full-time faculty should work with part-time faculty to ensure consistency across the physics program at an institution. Adjunct physics instructors are also expected to be available outside of class time to meet with students to work on student difficulties with the course.

P-5

Adjunct or part-time faculty should be supported by the full-time faculty and support staff at the college. Adjunct or part-time physics faculty should also be paid for one extra contact hour beyond the contact hours of the course, in many cases, as compensation for the additional time they are expected to put in.

Physics is different from many academic classes because it requires many demonstrations and laboratories to make the teaching effective. The services of support staff available to full-time faculty, such as a laboratory technician or a computer support person, should be made available to adjunct faculty whenever possible. Full-time physics faculty should mentor new adjunct faculty to help them use the resources available at the college to become effective teachers. Adjunct or part-time faculty must be compensated for the time they put in familiarizing themselves with lab equipment, setting up laboratories, and preparing lab demonstrations.

P-6

Continued professional development is required of all two-year college physics faculty.

Faculty are expected to avail themselves of professional development programs of their college, of universities, and of their professional association. The college should encourage and fund fully such activities.

P-7

Faculty should have available adequate travel funds to attend meetings associated with the physics and teaching profession.

Each two-year college should provide funds each year for at least one member of the department to attend a national meeting concerned with physics or teaching. In addition, the institution should provide funds for one or two regional or state meetings per year for each faculty member in the department. Two-year colleges should encourage the professional involvement of their physics faculty in growth-promoting activities. Colleges should allow faculty to occasionally miss class for professional development if arrangements are made for the class to be covered by a qualified physics instructor or for students to work on other appropriate activities such as projects in a computer lab.

AAPT regards these as a minimum standard for support of professional involvement. Since an instructor must keep up with his or her subject area and the strategies for teaching it, faculty should have a professional obligation to attend and participate in meetings of professional associations. The institution that employs the instructor has an obligation to provide support and encouragement so that physics faculty can interact with their colleagues in professional meetings.

P-8

The administration should encourage and financially support faculty fully for sabbaticals every six years.

Sabbaticals should be spent in activities that will promote professional growth with respect to personal teaching skills, technical competencies, studying new areas of physics, and general breadth of intellectual perspectives and understanding. Financial support should be provided for a full year of sabbatical leave for each faculty member at the minimum of every sixth year. Faculty members should be encouraged to assess in which area the need for growth is greatest in relation to the institution's commitments to students and devote sabbatical leaves to promoting growth in these areas.

P-9

Other forms of faculty development and scholarship should also be encouraged.

The department chairperson, dean, and president should work together to set faculty workloads, as needed, to give faculty members time for regular activities that will promote the continued professional growth of department members. Money should be available to the faculty member to do this work. The college foundation could be a source of these funds. Examples of such activities include: enrollment in appropriate courses by the faculty member; work with physics departments of other colleges and universities and their personnel; work with local high school or elementary teachers; membership and participation in the work of a professional society or societies; planning and preparing courses; library research in the field; working with local industry; updating and preparing teaching materials; reading journals; writing papers and preparing talks; and writing grant proposals.

P-10

Faculty members should have available services of support personnel so that their efforts on tasks expected of faculty members will be effective.

The support staff should include laboratory technicians, computer support and media support personnel, and secretarial support. Computer support needs are often college-wide and not unique to physics, and the college will often have campus-wide computer support staff. It is important that computer support be sufficient to ensure quick response (less than a couple of hours) to fix common problems without long downtimes, which can wreak havoc with a class schedule. Other tasks expected of support staff should include assembling lecture demonstrations, repairing equipment, maintaining computers, taking inventory of supplies and equipment, ordering routine supplies for laboratories, and setting up and taking down laboratories. Not all administrators will realize that physics is almost unique in its use of lecture demonstrations. These kinds of tasks can be handled in a more cost-effective manner by support personnel. If the faculty member is expected to do these tasks, adjustments to the teaching load will need to be made.

Budget Guidelines

B-1

Faculty compensation should be competitive with other colleges and universities.

The single most important factor to a quality physics program is a highly motivated and highly qualified faculty. These characteristics were described in another section of this document. It is virtually impossible to give specific guidelines on faculty salary because of the differences in colleges, programs, and regions of the country. If the college hopes to attract and hold high-quality physics faculty, it must offer a salary that is competitive with other colleges and universities in its area or state. In some colleges, this may be governed by state guidelines, collective bargaining agreements, and rank and length of service practices. In evaluating the total personnel support, other items must also be considered. There is a difference in average salaries in industry for different disciplines of expertise, and this should be reflected in the salary schedules or in special salary incentives.

B-2

The budget must provide for equipment purchase, replacement, and maintenance.

Physics at any level is an experimental laboratory science. Equipping and operating a quality physics teaching laboratory should be a goal of all physics programs. Calculation of the amount to budget for such activities is difficult to prescribe. Two models have been suggested by the broader physics community to estimate this cost.

The National Science Board Task Committee on Undergraduate Education of the National Science Foundation (NSF) recommends "enactment of special legislation aimed at achieving national norms for a minimum level of support for laboratory instrumentation (amounting to $2000 per engineering or science graduate per year, as recommended by bodies such as the National Society of Professional Engineers)." If this guideline is chosen, the physics department should be given a prorated share of the credit hours applied to the engineers or science majors in calculating the allocation for equipment acquisition and maintenance to the department. An appropriate budgetary amount should be at least $100 per student registered in laboratory courses.

Another possibility for estimating equipment and repair needs, if the NSF guideline is not used, is to use the equipment inventory. Ordinarily, an equipment budget is most appropriately related to the present equipment value. In this method, an institution should budget 14% of the inventory value of existing instructional equipment for acquisition of new instructional equipment and replacement of worn-out or obsolete apparatus each year. A 14% budget would mean that 14% of the equipment could be replaced each year. This means that a piece of equipment would have to last at least seven years. The cost of new equipment is rising rapidly. The rate of obsolescence is high in programs that need to remain current with technical developments. This is assuming that the physics laboratory is presently well equipped. A 14% figure is a conservative value and does not include computer, interface, and sensor replacement/updating.

About 25% of computer, interface, and sensor replacement value should be budgeted for new and replacement equipment each year. A 25% budget would mean that 25% of the equipment could be replaced each year. Each computer, interface, and sensor system would, therefore, have to last for at least four years.

Many administrators making budget decisions will not have a sense of how much it costs to operate a laboratory. It could be helpful to "cost out" a few experiments that are typically expected of freshman or sophomore-level courses to illustrate the need for orderly planning. It would be useful to set up a replacement cycle for all equipment in your laboratory.

Additionally, the budget should include some funds for trying out new experiments and activities. The budgeted amount should allow the purchase of one setup of a new and promising activity to try each year.

Approximately 2 to 5% of the inventory value should be budgeted each year to repair and maintain the laboratory equipment. The quality of technical support available to the department at each school will dictate the exact percentage within this range.

The budget should include sufficient funds for office supplies, normal laboratory supplies, mailing, duplicating, printing, and communication costs.

B-3

The budget should include funds for professional development.

Specific areas that should be included are:

1. Providing travel support for each faculty member to attend a national meeting and one or two regional or state meetings related to the area of physics education or research each year. (See guidelines C-9, C-10, and P-7.)

2. Establishing a program of tuition reimbursement for credit or noncredit courses taken to enhance teaching of physics-related courses. (See guideline P-6.)

3. Establishing and supporting a sabbatical leave program to encourage faculty to engage in study or research in their field every six years at full salary. (See guideline P-8.)

4. Providing support for faculty and departments to purchase books, journals, and computer programs, and to join professional societies. (See guidelines C-9, P-6, P-7, and P-9.)

B-4

The budget should include funds for support personnel.

Specific areas that should be included are:

1. Providing laboratory support through a lab technician/coordinator. For small, one-person departments, the laboratory support could be appropriate release time for the faculty member to spend the necessary time: to maintain, order, and replace laboratory equipment; to set up and break down laboratory activities; to set up, test, and break down demonstrations; and to develop and test new laboratory activities. For larger departments with multiple faculty members and/or adjunct faculty, an individual who has the appropriate expertise should be available to assist in doing these functions and to help adjunct faculty in setting up their laboratory activities and demonstrations. For larger one or two faculty member departments, it may be possible to "share" this individual with another department. For departments having three or more faculty members, there should be a full-time lab technician/coordinator to perform and coordinate these functions. (See guideline P-10.)

2. Access to secretarial assistance/support. To support the many functions that occur within the physics discipline/department, secretarial support should be provided. For larger departments, a full-time secretary should be provided.

3. Funding for support personnel to participate in professional development activities, which will help them do their jobs effectively.

4. Use of student assistants. Many of the secretarial, laboratory, and demonstration support activities can be greatly enhanced with student assistants. Besides the benefit to the student, student assistants are beneficial to faculty and the department in general and should be available. Student assistants should not be used as instructors for laboratory activities, but can be valuable in assisting qualified instructors.

5. Access to other support personnel, such as computer support personnel, audiovisual personnel, and others. With the extensive use of computers in physics departments, computer support personnel are essential for delivering quality classes and laboratory activities to students. If a department has multiple computer facilities, a person dedicated to computer and technology support may be necessary.

B-5

The budget should include additional support in areas such as:

1. A program review of the physics discipline/department by both college personnel and external personnel every five years;

2. The hosting of regional meetings, workshops, or other professional development opportunities as determined by the physics faculty;

3. The funding of local educational outreach activities, such as science teams, science fairs, science tests, and others as determined by the physics faculty; and

4. Student travel and expenses for field trips, attendance of professional conferences, and other activities as determined by the physics faculty.

Teaching Facilities Guidelines

F-1

There must be adequate laboratory space and equipment to meet the need for students to have personal experience in designing and performing experiments.

The space and equipment must be adequate to meet the needs of all courses without imposing debilitating difficulties, such as having to frequently set up and take down equipment because of schedule conflicts over the use of space and/or equipment. Space and equipment should be (a) available to the teacher during a planning period; and (b) available to students for special projects, make-up laboratories, and so on, outside of their regular physics class hours. Students who are involved in extensive project work should be provided with work space in which their equipment can remain secure and undisturbed for extended periods of time.

F-2

There must be certain basic physical conditions in the physics laboratory to ensure safety and to enhance proper teaching.

a. Laboratory space must be large enough for all students to participate in real experimentation.

b. There needs to be reliable, easy-to-use, state-of-the-art equipment including computers, sensors, and software.

c. There must be adequate ceiling height and means for hanging apparatus.

d. Tables with flat tops (no fittings are needed) are necessary for mechanics experiments that require a surface clear of obstructions.

e. Sinks, gas, and electricity should be provided in the room at a level convenient to the height of the tables.

f. Adequate lighting with light-dimming capacity should be available. The ability to fully darken the laboratory is important.

g. Safety equipment requirements are not as stringent as for chemistry laboratories but should include a fire extinguisher and safety goggles for those experiments where eye damage may result. There must be a safe source of electricity. Chemical and nuclear materials must be monitored and safely stored.

h. An equipment inventory should be maintained and instruction manuals for equipment should be kept on file. These are valuable aids to new instructors and adjunct faculty.

F-3

The classroom areas should have full audiovisual and computer-support capabilities and should be configured to allow students to interact with the instructor and each other easily.

Many audiovisual aids and computer materials are now an integral part of the teaching/learning process. They should not be left in an area far removed from the classroom because this practice reduces their usefulness.

Very few physics classes consist entirely of an instructor talking while students listen. Students are typically encouraged to interact with the instructor and each other, and the classroom layout should not discourage this interaction. The classroom should also be able to easily accommodate students working together in small groups.

A physics program should have at least one lecture room dedicated for physics instruction so that demonstrations may be set up well in advance of class time. This room should have the conventional utilities, hooks and brackets, screens, and projection equipment necessary to perform meaningful lecture demonstrations. There should also be adjoining space for storing, organizing, and assembling lecture demonstration apparatus.

F-4

Physics teaching requires proper demonstration apparatus and equipment.

Teaching and learning in physics is difficult without appropriate apparatus. The correct priority favors maximum opportunity for active student involvement with equipment in a laboratory or experimental setting. Since cost of the equipment or safety requirements may prohibit some student use, the room should have the capacity for apparatus demonstrations by the teacher before the whole class so that all students can clearly see and understand the demonstration.

F-5

A secure equipment storage area is needed in physics. Because of both safety and the need for security of expensive, easily breakable equipment, a proper storage area is essential.

F-6

Each faculty member needs a conveniently located and well-equipped office.

Each faculty member needs an office that is readily available to students and located to encourage faculty-student contact. The office should be near the physics laboratory and lecture room.

Faculty should have a computer/printer in their office. The computer should be connected to the Internet so that faculty can use e-mail and browse the web.

F-7

Apart from classrooms and introductory laboratory spaces, other specialized spaces must be provided as needed.

Physics faculty need ready and frequent access to smart and semi-smart classrooms. Semi-smart classrooms are equipped with a computer (with Internet access) for the instructor and a projection system to display what appears on the monitor on a large screen. Smart classrooms additionally have a computer (with Internet access) for each student or pair of students to use.

Access to a shop for building and repairing equipment is important. Provisions should be made for woodworking, metal working, and electronic work. Basic tools should be available and well cared for. Essential supplies should be kept in stock. Access to a darkroom can be useful in teaching physics.

F-8

All facilities (offices, classrooms, special spaces, and laboratories) and activities should be readily accessible to handicapped students.

F-9

Students should be able to easily find information in reference books and on the web in the college library, college computer labs, and also in the physics classrooms.

Ready access to information plays an integral part in laboratory and classroom work. Students benefit when they have access to information in the laboratory and classroom setting. Students should be able to find handbooks, dictionaries, and other reference books in the laboratory area and should be able to access the web to search for additional information.

F-10

The newly developed learning resources, as well as the “old” standards in physics, need to be available at the two-year colleges.

The library, media center, audiovisual center, science learning centers, physics departments, and any other area of the college involved in helping students learn physics need to be aware of the advances and make careful decisions regarding the use of the vast array of physics education materials available. This material might provide different learning approaches for the basic physics concepts.

Physics departments need to provide direction and help to librarians and media directors so that physics education collections (books, journals, films, videos, computer programs, videodiscs, etc.) can be strengthened in areas where they are weak and discarded if they are unlikely ever to be used again.

Distance-Learning and Internet Course Guidelines

D-1

Courses offered in nontraditional formats made possible by advances in technology such as the Internet, the World Wide Web, and two-way audio-video links must meet the same academic standards as traditional courses.

When used as a supplement to the traditional classroom experience, new technologies provide exciting opportunities for instructors and students to communicate and interact more extensively with each other. These technologies also make it possible for colleges to reach students who might not otherwise take a course at the college by allowing them to take the course without coming to campus regularly. When offering courses in nontraditional formats, instructors must overcome many challenges, including: providing laboratory experiences for students who do not visit campus regularly; monitoring students to prevent cheating during examinations taken off-campus; and dealing with varying levels of computer literacy among students (when using computers as the means of communication between the instructor and students). Instructors have found innovative ways to overcome these and other challenges when offering nontraditional courses. One way these challenges can be addressed is to require students to spend time in the traditional classroom for some portion of the course. The responses to the many challenges of nontraditional courses will often be unique to a particular institution because of its unique circumstances, but the result should always be that the nontraditional course meets the same academic standards as a traditional classroom course.

D-2

When instructors teach courses in nontraditional formats with students not in the classroom regularly, the instructor workload and compensation should reflect the actual time commitment required to teach the courses well.

Instructor workload and compensation traditionally have been tied to the amount of time the instructor spends in the classroom. Teaching a course in a nontraditional format typically reduces the time the instructor spends in the classroom, but increases the time the instructor spends on the course. No standard can be set for how teaching courses in nontraditional formats should be counted in determining instructor workload and compensation because each instructor teaching such a course faces different challenges with different resources. Institutions and instructors will need to adjust the workload and compensation of instructors teaching nontraditional courses to reflect the actual time required to teach these courses based on their experiences.

D-3

Developing new courses in nontraditional formats requires a substantial time commitment, and instructors developing these new courses must be given sufficient release time and/or other compensation.

Different instructors will take different amounts of time developing new courses in nontraditional formats because of the different skills each instructor has, the different resources available at each institution, and the different goals each course will try to meet. No instructor should be compelled to develop a course in a nontraditional format unless that instructor is satisfied that he or she will be given sufficient release time and/or compensation. Instructors should discuss the time and energy needed to develop a new nontraditional course with other instructors who have developed such a course before undertaking such a large project. Before an instructor begins developing a new course in a nontraditional format, the instructor and the administration of the college should have a clearly understood agreement on the release time and/or compensation the instructor will receive in order to develop the new course, as well as who will have copyright ownership of the materials developed for the course.

D-4

Adequate equipment, facilities, and technical support must be provided for instructors of distance-learning and Internet courses.

Instructors are not able to focus on teaching and learning if they are spending their time maintaining the equipment needed to communicate with their students. Nontraditional courses are not possible when the equipment needed for instructors and students to communicate is not available. The college should provide adequate support staff such that the necessary equipment is never unavailable for long periods of time and faculty can focus on teaching and learning. (See guidelines L-8 and P-10.)

Physics instructors of courses offered in both traditional and nontraditional formats must spend many hours preparing for their courses and grading assignments. Many instructors find it necessary to do some portion of this work at home during evenings and weekends if they are to maintain their personal life. The college should provide the means for these instructors to do some of the work of preparing for their courses and grading assignments from their homes. The equipment and services needed to meet this goal will depend on the technology used for communication between the instructor and the students. One example is that the college should provide a computer and a high-speed Internet connection at the homes of instructors teaching courses offered entirely over the web.

Appendix A

A Brief History of the Two-Year College in America

Although many disagree on where and when the first public two-year college was established (Greeley, Colo., in the 1880s; Saginaw, Mich., in 1895; or Joliet, Ill., in 1901), there is no disagreement that the idea for such an institution was being discussed by the end of the 19th century among both secondary school and university educators. The term "junior" college was first used in the late 1890s by William Rainey Harper, president of the University of Chicago, to describe the lower-division college he instituted within the university. This junior college allowed freshmen and sophomores to complete general education requirements before proceeding on to the more specialized work of the university. Harper initiated the use of the degree of Associate in Arts, Philosophy, and Science as a reward for students who should or did conclude their education at the end of the two-year junior college program. He also saw the degree as an inducement for students who were academically qualified and wished to continue their education in a professional school or the senior college of the university.

These reforms in higher education, initiated and/or advocated by Harper and other prestigious university administrators in the United States, sprang from a desire that American universities become institutions of research and knowledge production rather than transmittal, patterned after the German university system with its emphasis on graduate and specialized studies. They also encouraged high schools to set up junior colleges, a movement that had already been anticipated by some secondary school administrators who were faced with meeting the demands for postsecondary education by growing numbers of high school graduates. Small private and public four-year colleges that could not maintain enrollments in their upper-division courses were also urged to reorganize as junior colleges.

The development of the two-year technical college began concurrent with the growth of the academic junior college in the early 1900s. Rapid industrialization and the mechanization of agriculture in the United States created demands for a more technically trained workforce. This brought about the establishment of two-year postsecondary institutions whose sole mission was the training or retraining of the American worker and ultimately led to the establishment of the Associate in Applied Science degree for students completing terminal two-year technical/vocational programs of study. Existing junior colleges also began to offer vocational programs in addition to their transfer-oriented curriculum so that by the 1930s, occupational-technical education had become a permanent component of the two-year college curriculum. By 1945–46, there were 294,475 students enrolled in 648 regionally accredited two-year colleges in the United States, of which less than 50% (315) were publicly supported.

The use of the term "community" college first appeared in the recommendations of the U.S. Commission on Higher Education, convened in 1947 by President Truman. Spurred on by the establishment of financial scholarships based on military service during World War II through the federal G.I. Bill of 1944, the Commission saw the establishment of public, locally controlled, multipurpose, two-year community-based colleges as the logical vehicle for expanding and diversifying the higher education opportunities available to American adults and youths. The federal government took the position that equality of educational opportunity beyond the high school years was a goal to be pursued and continued its advocacy of the public community college through the 1950s and into the 1970s. It provided financial support both to two-year college students and to states desiring to formulate Master Plans for Higher Education that included the establishment of statewide public community college systems. The fruit of this support is seen in the statistic that by 1996, there were 1,132 regionally accredited two-year colleges in the United States, of which only 12.1% (137) were privately operated. The number of public two-year colleges more than tripled over the 51-year span between 1945 and 1996.

Appendix B

Comprehensive Mission of the Community College

Traditionally, the comprehensive mission of the community college has included all or part of the following:

A. Lower-Division Collegiate Education

This encompasses courses in liberal arts, humanities, science, mathematics, engineering, and technology geared to ensure that students can successfully transfer to professional schools or to baccalaureate programs at four-year colleges or universities.

B. Occupational-Technical Programs

These are one- and two-year terminal courses of study that prepare students to enter existing or new and emerging vocations and technical careers. These may also be individual courses that provide opportunities for workers to update or upgrade present job skills, acquire new job skills, or obtain the necessary retraining needed to make a career change.

C. General Education/General Studies Program

This is a terminal associate degree course of study that includes a core of general education courses from the areas of humanities, social science, science, and mathematics after which the student may choose a "major" emphasis from a variety of program areas, including the occupational-technical areas.

D. Developmental/Remedial Programs and Services

These are courses of study and academic support services for those students not having the requisite academic background and/or cognitive skills to be successful in achieving their postsecondary education goals.

E. Student Services and Programs

These may include personal, academic, and career counseling; student admissions and records; student assessment and advising regarding placement in courses; student orientation; job placement services; the administration of financial aid programs; student cocurricular and extracurricular activities; student health services; developmental and support services for special student groups like the handicapped or re-entry women; childcare services; legal assistance services; and credit or noncredit human development courses and workshops that assist students in building personal, social, and academic skills.

F. Community Education and Services

These may encompass the Adult Basic Education (ABE) program for functionally illiterate adults; the General Equivalency Diploma (GED) program aimed at increasing the number of adults earning high school diplomas; the English as a Second Language (ESL) program for the increasing immigrant populations in the community; noncredit continuing education courses; evening and/or weekend academic credit courses for part-time adult students; credit or noncredit courses offered through local cable TV or radio; counseling (personal, family, career, educational) and assessment services; use of campus athletic facilities; nontraditional credit programs like the College-Level Examination Program (CLEP) or credit by examination for course work completed at nonaccredited institutions or through one's private study; workshops, seminars, and short courses to meet the continuing education needs of local business and industry; as well as cultural programs.

laboratories

release time

computer

travel

equip

education