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ABSTRACT

The quality of a two-year college's physics program is determined in part by the quality of preparation and the overall workload of its teachers, along with the provision for adequate budgets, facilities, and support services. The guidelines presented in this booklet were prepared by a task force of the American Association of Physics Teachers (AAPT) to assist college administrators and science teachers in establishing and developing reasonable standards for physics instruction in their institutions. These guidelines are presented under several different headings: (1) "Curriculum Guidelines"; (2) "Laboratory Guidelines"; (3) "Personnel Guidelines"; (4) "Budget Guidelines"; and (5) "Teaching Facilities Guidelines". In addition, a discussion of how to start a physics program assessment at a two-year college is included. A brief history of the two-year colleges in the United States and a mission statement for two-year colleges are appended. (CW)

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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.

These guidelines were developed by a task force on physics in the two-year colleges, a committee concerned with the quality of instruction in two-year colleges. A preliminary draft was circulated widely within the physics-teaching profession. These guidelines have been adopted by the AAPT 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). 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.

"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. Specialized courses in physics are often requested for students in specific two-year vocational and technical programs. Also, the lack of adequate preparation in mathematics and/or science by many two-year college students necessitates the offering of developmental courses prior to their enrollment in the conventional college physics courses.

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 to the deemphasis 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 the diverse backgrounds and abilities of entering students;
- 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; and
- augment the continuing education and other local community physics education needs.

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 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 and Junior Colleges (AACJC) recognizes them as regionally accredited, postsecondary institutions at which the associate degree is the highest credential awarded. [Jim Palmer (Editor), "A Summary of Selected National Data Pertaining to Community, Technical, and Junior Colleges," *Appendix for AACJC Statistical Yearbook 1988* (AACJC, Washington, DC, 1988), p. A2.] 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 twenty-first 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 they should also describe now 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. Current data [National Center for Education Statistics, *National Estimates of Higher Education: School Year 1988–89* (U.S. Department of Education, Washington, DC, December 1988); Jim Palmer (Editor), "A Summary of Selected National Data Pertaining to Community, Technical, and Junior Colleges," *Appendix for AACJC Statistical Yearbook 1988* (AACJC, Washington, DC, 1988), pp. A4–A5; National Center for Education Statistics, *Trends in Minority Enrollments in Higher Education, Fall 1976–Fall 1986* (U.S. Department of Education, Washington, DC, April 1988)] show that two-year colleges serve a credit enrollment population that encompasses:

- 53 percent of all entering college freshmen;

- 43 percent of all college undergraduates;
- 43 percent of all Black college students;
- 55 percent of all Hispanic college students;
- 57 percent of all American Indian/Alaskan Native college students; and
- 15 percent of all nonresident alien college students.

Presently, over 5 million learners a year enroll for credit in community, technical, or junior colleges; the majority (over 60 percent) are part-time students, compared to a 1970 part-time student enrollment of 40 percent. 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 over 28. 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 presently account for over 53 percent of community college credit enrollments as compared to 47 percent in 1976.

Although the above establishes a national profile of today's two-year college population and, to some extent, a profile of the students served by a community college's physics program, no hard data exist as to the number (or percent) and types of students who avail themselves of the various courses offered by two-year college physics departments. At present, this must be inferred from other statistics and/or anecdotal information. A physics department embarking upon an assessment of its program would be well advised to make use of its institutional data base 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 both by 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 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.

demic 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; and
- Use and effectiveness of articulation programs with "feeder" high schools, community business and industry leaders, other departments within the college for which physics provides service courses, as well as the science and engineering departments of four-year transfer institutions.

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 seven categories:

1. **General Education Courses**

   Two-year degree requirements often include a science requirement necessitating basic science courses. These courses may be called "physics" or "physical science." The physics component in these courses would generally be descriptive.

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, 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.

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.

7. **Preparatory Courses**

   These courses are for students who are not prepared to enter directly into technical or transfer-level physics courses. They usually emphasize vocabulary, problem-solving skills, basic concepts, and activities to improve formal thought process.

C-2

When designing a physics course, the content must be consistent with the needs of the student.

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-3

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

Pretests can aid the instructor in determining 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 evaluating quantitative skills and reasoning or problem-solving abilities are separated in such evaluations. *Development* or *refinement* of problem-solving skills and reasoning ought to be one of the primary goals of most physics courses.

C-4

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

Students do not enter a physics course as an "empty vessel." 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 subsequently be taught 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-5

A variety of "hands-on" activities 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 laboratory experiences, lecture demonstrations, and classroom activities are all essential to maximize student learning. 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 combines many different skills and concepts.

C-6

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

Appropriate advice on courses, or effective help for students encountering difficulty in a physics course, only occurs if those responsible for such activities are aware of the goals and expectations of the physics courses offered by the college.

C-7

Insofar as possible, physics departments ought to evaluate and implement available technologies which 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. Such technologies must not require more of the instructor's time. Evaluation of existing and new technologies must be an ongoing process and should be considered in the instructor's workload.

C-8

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

The primary role of instructors in two-year colleges is teaching. Continual improvement of instruction ought to be one of the most important goals. This can be accomplished by trying new ideas and by considering the implications of research in physics education. Promising results of a physics teacher's activities should be shared at local, regional, or national meetings. (AAPT offers formats for sharing activities.) Faculty should be encouraged to attend professional meetings and support should be provided to do so.

C-9

Opportunities must 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. The goals of such courses should be to develop (a) an understanding of a few basic scientific concepts, and (b) arithmetic reasoning.

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 include a minimum of three hours per week.

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 limitations of shorter laboratory times encourages the use of "cookbook" activities.

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 pairs of students to share one entire set of equipment.

Most introductory laboratory activities are not elaborate enough to fully involve more than two 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 one in computing the contact hours in laboratory instruction. This practice is in di ct 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 deemphasize 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

A laboratory instructor's required teaching responsibilities should not include serving as a laboratory technician.

Each weekly lab session requires tasks in addition to pedagogical responsibilities. These include distributing and storing of weekly lab equipment, maintenance of equipment, 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 women, minorities, and the physically disadvantaged.

P-3

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

a. Fifteen contact hours per week;

b. Twenty-four average student contacts per hour; and

c. One contact hour of workload 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.

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

$342 \div 15 = 22.8$ average contacts per hour

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, only extraordinary efforts by the teacher can prevent a reduction in the quality of the physics or astronomy program.

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 over 25 percent of the class sections offered.

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.

P-5

Adjunct or part-time physics instructors should be given one extra contact hour per course in most cases.

Physics is different from many academic classes because it requires many demonstrations and laboratories to make the teaching effective. If adjunct or part-time instructors are to be expected to set up laboratories or prepare appropriate demonstrations for lecture sections, they need to be given credit for this work.

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 to support the travel and subsistence to a national meeting concerned with physics or teaching for at least one member of the department each year. 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. Such activities during the school year may be facilitated by using replacement faculty members to make possible some reductions in teaching and other responsibilities.

The 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 the area of greatest need.

P-9

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

The department chairperson, dean, and president should work together to set faculty workloads, as needed, to permit 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; and updating and preparing teaching materials.

P-10

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

In addition to secretarial support, the support staff should include laboratory technicians and media support personnel. The specific tasks expected of support staff should include assembly of 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

Establish compensation for faculty 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 a specific guideline on faculty salary because of the differences in schools, programs, and regions of the country. If the school 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 schools, 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

A budget should be planned that includes for professional development.

Specific areas that should be included are:

1. Providing travel support for each faculty member to attend each year a national, and one or two regional or state meetings related to the area of physics education or research. (See guidelines C-9 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 every six years at full salary to engage in study or research in their field. (See guideline P-8.)
4. Providing support for faculty and departments to purchase books, journals, computer programs, and join professional societies. (See guidelines P-6, P-7, and P-9.)

B-3

Budget 14 percent of physics equipment replacement value for new and replacement equipment each year. A 14-percent budget would mean that 14 percent of the equipment could be replaced each year. Each piece of equipment would, therefore, have to last for at least seven years.

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. Since the physics course is an underclass course, an appropriate budgetary amount should be $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 10 percent 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 10-percent budget would mean that 10 percent of the equipment could be replaced each year. This means that a piece of equipment would have to last at least ten 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 10-percent figure is too conservative with the heavy and hard use of an introductory physics laboratory.

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.

B-4

Budget a reasonable sum for regular equipment maintenance.

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

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 needs to 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 must be adequate ceiling height and means for hanging apparatus.

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

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

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

f. 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.

g. There needs to be reliable, easy-to-use, state-of-the-art equipment.

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 and preparatory room areas should have full audiovisual and computer-support capabilities.

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 the usefulness of film loops, computer programs, and other audiovisual aids.

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

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

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

A darkroom which may double as a light laboratory is very useful in physics. A shop for building and repair of 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.

F-7

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

F-8

Faculty should have a computer/printer in their office.

F-9

General reference works may be kept in the library or media center, but some should be found in the classroom and laboratory areas as well.

References play an integral part in laboratory and classroom work. Some teaching/learning aids can be more helpful if kept in the laboratory area—calculators, audiovisual aids for film loop work, computer terminals, dictionaries, handbooks, and so on. Conference and small-group work space might also be located within the laboratory.

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 that is 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. In addition to the conventional formats of 16-mm films, single-concept film loops, film strips, and books, there has been a growth in the availability of a wide variety of "new" media. 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.

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 (Greely, Colorado, in the 1880s; Saginaw, Michigan, in 1895; or Joliet, Illinois, in 1901), there is no disagreement that the idea for such an institution was being discussed by the end of the nineteenth century among both secondary school and university educators. The term "junior" college, first used in the late 1890s by William Rainey Harper, president of the University of Chicago, described the lower-division college he instituted within the university so that freshmen and sophomores could 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 who 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 U.S. 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 percent (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. Taking the position that equality of educational opportunity beyond the high school years was a goal to be pursued, the federal government continued its advocacy of the public community college through the 1950s and into the 1970s by its 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 1987, there were 1,211 regionally accredited two-year colleges in the United States, of which only 12.5 percent (151) were privately operated. This represents a 340 percent increase in the number of public two-year colleges over the 42-year span between 1945 and 1987.

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, and mathematics 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. They 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 co-curricular 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.