



Undergraduate Physics Program at Kent State University

This brochure is mainly for the benefit of the undergraduate students in the Department of Physics at Kent State University. The information in this guide is the result of deliberations of the Undergraduate Curriculum Committee. One of the principal goals of the Physics Department is to become and remain a leading department in the state and the nation. Since undergraduate students are members of the Department, quality of performance by undergraduate students is stimulated and recognized. Contributions and constructive suggestions by undergraduate students toward these goals are welcome.

WHO SHOULD MAJOR IN PHYSICS?

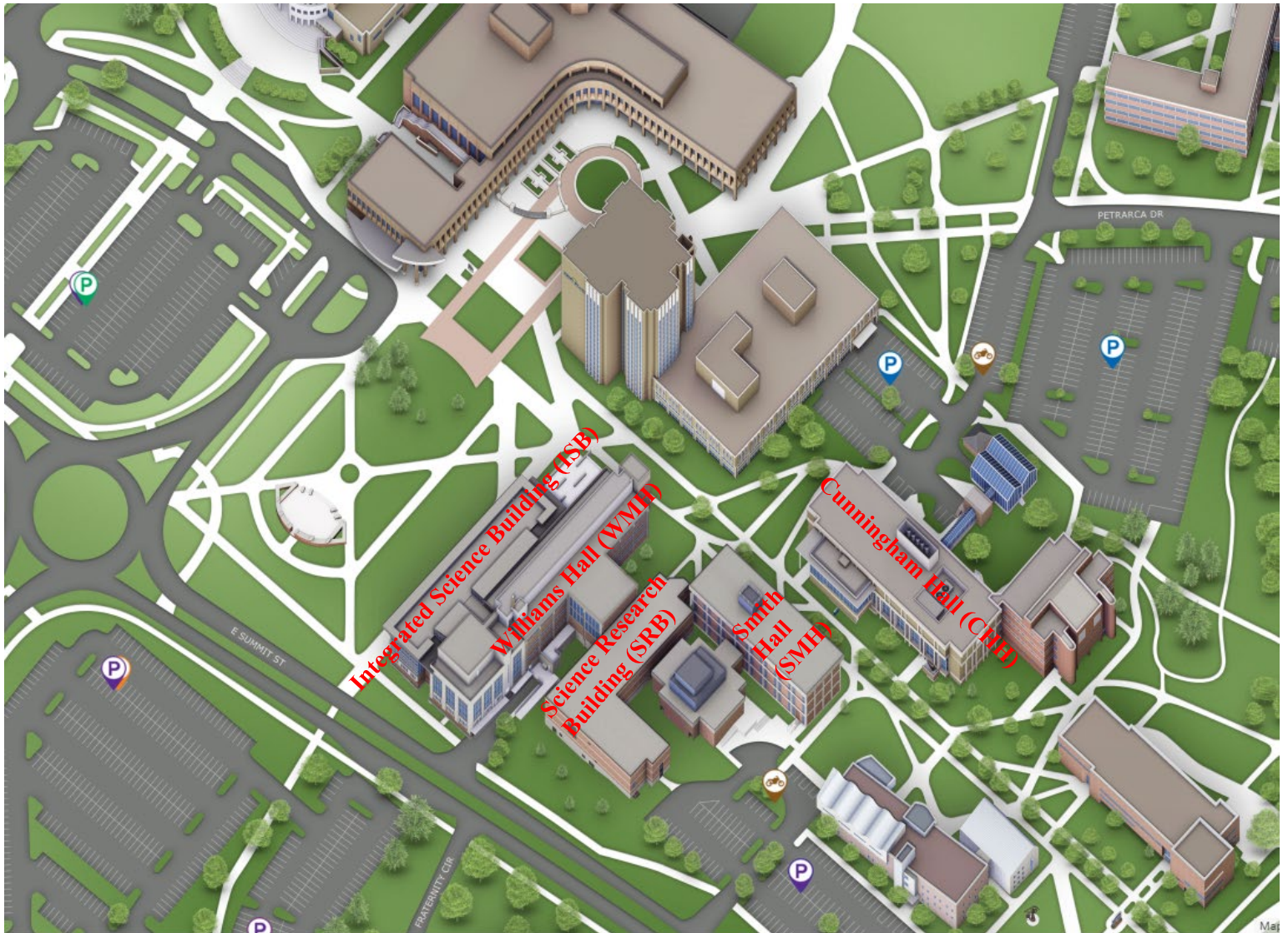
If you are curious about the basic nature of the physical universe, you should consider majoring in physics. Concerned with matter and energy, physics is a science based on precise measurements and broad generalizations. Freely translated, this means that physics is the study of what makes the universe tick -- a study encompassing the largest and smallest scales of the universe; a study that attempts to explain all observed phenomena in terms of the least number of rules. People who study physics often are called by the beauty of this way of looking at the world. The discoveries and laws that have resulted from experimental and theoretical research in physics are basic to many of the other sciences -- and to our way of life in the age of high technology. Physicists are employed by major industries to apply the recent advances and technology developed by basic research in physics. Few careers offer as much stimulation and challenge as a career in physics.

PHYSICS AT KENT STATE UNIVERSITY

The physics faculty at Kent State University are internationally known for their productivity and creativity in research, particularly in liquid crystal physics and nuclear physics. The faculty includes two award-winning teachers. Our Center for Nuclear Research and the Advanced Materials and Liquid Crystal Institute® provide special opportunities for both undergraduate and graduate students. The total physics program at Kent is small enough (the typical size of our upper-level classes is about ten to twenty students) to assure individualized attention to students, yet large enough to offer a wide spectrum of courses and opportunities that characterize a graduate research institution. Work-study and other student employment provide direct involvement in forefront research programs. In addition to our baccalaureate programs, the Physics Department at Kent State University offer graduate programs leading to masters and doctoral degrees.

The Physics Department is located in Smith Hall, which is on East Summit Street in Kent, Ohio. Parking is available in the lot just east of the building (see map below).

KENT STATE UNIVERSITY



BACCALAUREATE PROGRAMS

Students in the College of Arts and Sciences may pursue either the Bachelor of Science (BS) degree or the Bachelor of Arts (BA) degree.

B.A. Program

The BA Program can be used to prepare physics majors for such diverse fields as secondary education, patent law, or interdisciplinary science careers. A large proportion of elective courses allow the student to complete a second major in such fields as biology, botany, chemistry, English, geography, geology, mathematics, philosophy, political science, or psychology, in preparation for an interdisciplinary career. It is also possible to enter graduate work in physics after completing this program.

B.S. Program

The professionally oriented BS program serves as preparation either for graduate work or for entrance into positions in a variety of industries or government service. Any of eight concentrations help the physics major focus on various emphases:

RESEARCH

The research concentration prepares majors for further study at the graduate level. This program trains students in logical thinking and problem solving using both analytical and computational methods. It also furnishes students with a comprehensive understanding of the basic laws and principles that govern the physical world. Academic assessment and GRE results keep the program up to date via curricular revisions. This program is a popular steppingstone to graduate degrees not only in physics, but also in engineering, astronomy/astrophysics, and materials science.

APPLIED PHYSICS

The applied physics concentration prepares students for immediate entry into careers in industry. Course requirements include electronics, introduction to computer programming, and data analysis and computational physics techniques. While rooted in the basic principles of physics, this program is optimized for students concerned with the application of physics in practical devices and systems.

CHEMISTRY

The chemistry concentration is designed for students with a strong interest in both physics and chemistry who may wish to prepare for graduate study in chemical physics or for work in a high-technology materials-related research and development laboratory.

BIOLOGICAL SCIENCES

The biological sciences concentration is for students with a strong interest in both physics and biological sciences who may wish to prepare for graduate study in biophysics or for work in a biotechnology company.

COMPUTER SCIENCE

The computer science concentration provides a foundation in physics while emphasizing the use of computer software in scientific applications. Graduates are prepared for computer-related careers that require an understanding of the underlying science as well as knowledge of relevant computer applications.

MATHEMATICAL PHYSICS

The mathematical physics concentration provides students with a strong understanding of applied physical theory, its applications and the underlying mathematics. This training, valuable for start-up positions with a number of industries, may also serve as preparation for graduate work in either physics or mathematics.

ENTREPRENEURSHIP

The entrepreneurship concentration is designed to prepare physics majors for various aspects of starting or managing a scientific business.

PRE-MEDICINE/PRE-OSTEOPATHY/PRE-PODIATRY

The pre-medicine/pre-osteopathy concentration is designed to prepare physics majors for further study leading to careers in medicine.

A comparison of the BS and BA programs at Kent State University follows on page 5. A year of college chemistry and one year of a foreign language is required for the BS programs. The BA program requires two years of foreign language but includes several elective hours, which provide for a wide variety of dual major possibilities. In addition to the core requirements listed on page 5, the BS program includes additional requirements specific to each concentration; these concentration requirements are listed on pages 6-9. The elective physics courses available to majors are shown on page 10. Note that some of these electives are recommended courses for particular concentrations in the BS program. Students in the BA program may replace three (3) hours of physics electives with either PHIL 41035 (Philosophy of Science) or ENG 20002 (Technical Writing) with their advisor's permission.

PHYSICS CORE REQUIREMENTS

BA DEGREE		PHYSICS	BS DEGREE	
Course #	Semester hrs.		Course #	Semester hrs.
12000	1	Introductory Physics Seminar	12000	1
23101	5	General University Physics I	23101	5
23102	5	General University Physics II	23102	5
30020	2	Intermediate Physics Laboratory	30020	2
35101	4	Classical Mechanics	35101	4
36001	3	Introductory Modern Physics	36001	3
36002	3	Applications of Modern Physics		
40020	2	Advanced Physics Laboratory	40020	2
		Internship in Physics	40092	2
45201	4	Electromagnetic Theory	45201	4
8 – BA Physics Electives			34-40 BS Option Requirements & Electives	
MATHEMATICS				
12002	5	Analytic Geometry & Calculus I ¹	12002	5
12003	5	Analytic Geometry & Calculus II	12003	5
32051	4	Mathematical methods in the Physical Sciences I	32051	4
32052	4	Mathematical methods in the Physical Sciences II	32052	4
CHEMISTRY				
		General Chemistry I	10060	4
		General Chemistry II	10061	4
		General Chemistry Lab I	10062	1
		General Chemistry Lab II	10063	1
	55	Major Requirement Totals		90
KENT CORE/GENERAL REQUIREMENTS				
	1	Destination Kent State: FYE		1
	6	Composition		6
	14	Foreign Language		8
	9	Social Science ²		6
	9	Humanities and Fine Arts ²		9
	6	Additional		
	20	General Electives		
	120	TOTAL FOR GRADUATION		120

¹ Math 12001 (Algebra and Trigonometry) is a prerequisite course, which the student with sufficient background should bypass.

² Two Diversity courses are required. One must be taken in the Kent Core program. One of the two Diversity courses must address domestic issues and the other must address global issues

B.S. CONCENTRATION REQUIREMENTS

RESEARCH CONCENTRATION			
CS	13011	2	CSIA – Procedural Programming
CS	13012	2	CSIB – Object Oriented Programming
PHY	36002	3	Applications of Modern Physics
PHY	45301	3	Thermal Physics
PHY	45403	3	Data Analysis and Computational Physics Techniques
PHY	46101	4	Quantum Mechanics
		9	Physics Electives ¹
		8	General Electives
Total Required		34	
APPLIED PHYSICS CONCENTRATION			
CS	13011	2	CSIA – Procedural Programming
CS	13012	2	CSIB – Object Oriented Programming
PHY	22564	3	Introduction to Materials Physics
PHY	32511	4	Electronics
PHY	36002	3	Applications of Modern Physics
PHY	45403	3	Data Analysis and Computational Physics Techniques
PHY	45501	3	Electromagnetic Waves and Modern Optics
		6	Physics Electives ¹
		8	General Electives
Total Required		34	

¹These courses may be replaced with physics-related electives selected from mathematics or the natural sciences, with Curriculum Advisor's permission.

CHEMISTRY CONCENTRATION			
CHEM	30105	3	Analytical Chemistry I
CHEM	30107	1	Analytical Chemistry Lab I
CHEM	30301	2	Inorganic Chemistry I
CHEM	30481	3	Organic Chemistry I
CHEM	30482	3	Organic Chemistry II
PHY	36002	3	Applications of Modern Physics
PHY	45301	3	Thermal Physics
PHY	46101	4	Quantum Mechanics
		6	Physics Electives
		6	General Electives
Total Required		34	
BIOLOGICAL SCIENCES CONCENTRATION			
BSCI	10110	4	Biological Diversity
BSCI	10120	4	Biological Foundations
BSCI	30140	4	Cell Biology
BSCI	30156	3	Elements of Genetics
BSCI	40163	3	Organic Evolution
PHY	45301	3	Thermal Physics
PHY	46101	4	Quantum Mechanics
		3	Major Upper-Division Electives
		6	General Electives
Recommended Major Electives			
BSCI	40158	3	Molecular Biology
CHEM	30481	3	Organic Chemistry I
PHY	41010	3	Biophotonics
PHY	44600	3	Introduction to Biological Physics
Total Required		34	

COMPUTER SCIENCE CONCENTRATION			
CS	13011	2	CSIA – Procedural Programming
CS	13012	2	CSIB – Object Oriented Programming
CS	23001	4	CS II – Data Structures and Abstraction
CS	23022	3	Discrete Structures for Computer Science
CS	42201	3	Introduction to Numerical Computing I
PHY	36002	3	Applications of Modern Physics
PHY	46101	4	Quantum Mechanics
		6	Physics Electives
		7	General Electives
Total Required		34	
MATHEMATICAL PHYSICS CONCENTRATION			
CS	13011	2	CSIA – Procedural Programming
CS	13012	2	CSIB – Object Oriented Programming
PHY	36002	3	Applications of Modern Physics
PHY	45401	4	Mathematical Methods in Physics
PHY	45403	3	Data Analysis and Computational Physics Techniques
PHY	46101	4	Quantum Mechanics
		9	Physics Electives
		7	General Electives
Total Required		34	
ENTREPRENEURSHIP CONCENTRATION			
ACCT	23020	3	Introduction to Financial Accounting
(or) ENTR	37040	3	Entrepreneurial Tools
ECON	22060	3	Principles of Microeconomics
ENTR	27056	3	Introduction to Entrepreneurship
ENTR	27466	1	Speaker Series in Entrepreneurship
ENTR	37065	3	Entrepreneurial Finance
MKTG	25010	3	Principles of Marketing
		9	Physics Upper Division Electives
		9	General Electives
Recommended General Electives			
ENTR	47047	3	Strategic Dilemmas in Entrepreneurship
Including One from the Following:			
ENTR	37045	3	Sales in the Entrepreneurial Venture
ENTR	37075	3	Entrepreneurial Marketing
MKTG	35056	3	Social Media Marketing
Total Required		34	

PRE-MEDICINE/PRE-OSTEOPATHY/PRE-PODIATRY CONCENTRATION			
BSCI	10120	4	Biological Foundations
BSCI	30140	4	Cell Biology
BSCI	30156	3	Elements of Genetics
BSCI	30171	4	General Microbiology
CHEM	30475	1	Organic Chemistry Lab I
CHEM	30476	1	Organic Chemistry Lab II
CHEM	30481	3	Organic Chemistry I
CHEM	30482	3	Organic Chemistry II
PSYC	11762	3	General Psychology ¹
SOC	12050	3	Introduction to Sociology ¹
Plus 3-4 hours from the following:			
BSCI	30130	3	Human Physiology
BSCI	40430	3	Animal Physiology
Plus 4 hours from the following:			
CHEM	30284	4	Introductory Biological Chemistry
CHEM	40245	4	Biological Foundations of Medicine
Plus 3-4 hours from the following:			
BSCI	30518	4	Vertebrate Anatomy
BSCI	40174	3	Immunology
BSCI	40517	3	Medical Histology
PHY	41010	3	Biophotonics
PHY	44600	3	Introduction to Biological Physics
			General Electives

¹Satisfies Kent Core Social Sciences and Domestic Diversity.

ELECTIVE PHYSICS COURSES

(Courses Not Contained Within BS or BA Program Cores)

COURSES OFFERED DURING FALL TERMS		
32511	4	Electronics
36002	3	Applications of Modern Physics
40060	1-3	Physical Literature
40096	1-6	Individual Investigation
40099	1-10	Senior Honors Thesis
44600	3	Introduction to Biological Physics (offered in odd number years)
45401	4	Mathematical Methods in Physics
COURSES OFFERED DURING SPRING TERMS		
22564	3	Introduction to Materials Physics (offered in even-numbered years)
34000	3	Cosmology (offered in odd-numbered years)
40060	1	Physical Literature
40095	1-3	Special Topics
40096	1-6	Individual Investigation
40099	1-10	Senior Honors Thesis
41010	3	Biophotonics
44802	3	Astrophysics (offered in even-numbered years)
45403	3	Data Analysis & Computational Physics (offered in odd-numbered years)
45501	3	Electromagnetic Waves & Modern Optics (offered in even-numbered years)
46101	4	Quantum Mechanics
46301	4	Introduction to Nuclear & Particle Physics (offered in even-numbered years)
46401	3	Introduction to Solid State (offered in odd-numbered years)
COURSES OFFERED DURING SUMMER TERMS		
40060	1-3	Physics Literature
40096	1-6	Individual Investigation
40099	1-10	Senior Honors Thesis

Warning: The physics courses listed below are offered primarily to serve the needs of students who are not physics majors.

These courses will not normally count toward fulfilling requirements for a major in physics.

11030	3	Seven Ideas that Shook the Universe
12111	3	Physics for Health Technologies ¹
12201	3	Technical Physics I ¹
12202	4	Technical Physics II ¹
13001	4	General College Physics I ²
13002	4	General College Physics II ²
13011	3	College Physics I ²
13012	3	College Physics II ²
13021	1	General College Physics Lab I ²
13022	1	General College Physics Lab II ²
21040	3	Physics in Entertainment and the Arts
21041	1	Physics in Entertainment and the Arts Laboratory
21430	3	Frontiers in Astronomy
21431	1	Frontiers in Astronomy Laboratory

Representative course schedules for each of the BS degree concentrations and for the BA program are available on the website:

<https://www.kent.edu/physics/sample-schedules-baccalaureate-degrees>

Printed versions are available from the Department of Physics upon request. Kent requires the undergraduate student to complete 120 hours to obtain a baccalaureate degree in physics.

¹ Courses offered only at the Regional Campuses.

² PHY 13001-02 and PHY 13011-12 do not require the use of calculus. PHY 23101-02, which uses the calculus, should be taken by physics majors.

COMBINED BACCALAUREATE AND MASTERS PROGRAM

Physics majors with outstanding records may be eligible for enrollment in a combined baccalaureate and master's (BS/MA) program in physics. To be eligible, students must have at least junior standing and have achieved a minimum GPA of

- 3.50 after 60 semester hours
- 3.40 after 75 semester hours
- 3.30 after 90 semester hours
- or 3.20 after 105 semester hours

The following procedure must be followed for admission to this program:

1. Completing the Application for Admission.
2. Completing the Combined Baccalaureate and Master's Program form which includes:
 - a. Listing the courses at the undergraduate level that need to be taken for the baccalaureate degree;
 - b. The beginning date for graduate study;
 - c. Listing of graduate courses to be utilized in satisfying the undergraduate degree.
3. Providing three letters of recommendation from instructors who are familiar with the students' achievements and their intended academic goals.

The minimum credit-hour requirements for graduate courses in the combined BS/MA program are 32 semester hours, with no more than half at the 50000 level. Up to 12 semester hours of the graduate courses may be applied toward completion of the BS requirements as well. The State of Ohio requires a minimum of 150 credit hours to receive a combined bachelor's and master's degree; a minimum of 120 semester hours earned toward graduation for the bachelor's degree plus a minimum of 30 semester hours earned toward graduation for the master's degree.

ADVISORS FOR PHYSICS MAJORS

The Physics Department's Undergraduate Coordinator will select a Curriculum Advisor for each new physics major. The Curriculum Advisor will advise and counsel the physics major on his/her degree program.

THE HONORS SCHOLARSHIP IN PHYSICS

The Physics Department, together with the Honors College at Kent State University, also offers an *Honors Scholarship in Physics*, which is presented annually to one or two outstanding high school seniors, who agree to become physics majors at Kent State University. The recipients also become members of the Honors College. The amount of the scholarship ranges from \$1,500 to \$3,500 per year, depending on the qualifications of the recipient. The scholarship is renewable yearly for up to four years or until graduation, whichever comes first, subject to each recipient maintaining scholastic standards agreed upon jointly by the Physics Department and the Honors College.

SOCIETY OF PHYSICS STUDENTS (SPS)

Social and intellectual activity is provided by the Society of Physics Students, a professional association designed for students. Meetings are typically held weekly with refreshments provided by the Department of Physics. For more information, visit the KSU SPS website:

<https://www.kent.edu/physics/society-physics-students>

STUDENT AWARDS

The Physics Department at Kent State University recognizes outstanding scholastic achievement in physics by annually offering various awards to undergraduates, including:

Pearson Award in Physics

This award is presented to the physics major who, during the year of the award, graduates with the highest scholastic average in physics. This award consists of a certificate and approximately \$250 worth of books presented by Pearson.

John Wiley Award in Physics

This award is presented to the student who, during the year of the award, achieves the most outstanding performance in the introductory University Physics sequence. This award consists of a certificate and approximately \$250 worth of books presented by John Wiley and Sons, Inc.

Center for Nuclear Research Award

This award recognizes undergraduate physics majors who achieve outstanding performance in one of the upper-level modern physics courses related to nuclear or particle physics (Intro. Modern Physics, Quantum Mechanics, or Intro. Nuclear and Particle Physics). Students are eligible to win this award only once. The award consists of recognition and a monetary prize of \$250.

ACADEMIC ASSESSMENT

The College of Arts and Sciences at Kent State University has adopted a policy that requires all graduating seniors to undergo mandatory outcome assessment. Physics majors may satisfy this graduation requirement by taking the Major Field Achievement Test (MFAT) in Physics, which is administered by the Physics Department at the end of each term.

GRADUATE RECORD EXAM (GRE)

Students planning to enter graduate school after receiving a baccalaureate degree normally are expected to take the Graduate Record Exam (GRE). The computer-based General Test is administered in a secure environment on a continuous basis in an ETS-authorized test center. For further information, visit:

<https://www.kent.edu/physics/graduate-record-exam-gre>

PHYSICS AS A CAREER

Most physicists are employed by educational institutions, industrial firms, government laboratories, or federally funded research and development centers. Vocations in physics fall into four major categories:

Research

Basic research has as its goal the understanding of physical phenomena. Applied research leads to the solution of problems of practical importance or of significant commercial value.

Development and Design

Work in this area utilizes both basic and applied research to improve existing products, processes, and instruments, and to develop new ones.

Teaching

Many physicists are employed in academic institutions, including instructors at the high school, community college, college, and university levels. In the latter, research and teaching are often combined.

Management and Other Areas

Physicists can be found in a wide variety of areas such as research administration, university administration, science reporting, technical management or marketing, and in such fields as metallurgy, electronics, food processing and packaging, health and radiation safety, pollution control, computer technology, or a broad and continually expanding array of other possibilities.

To become a *professional* in the field, physics, like all the sciences and mathematics, medicine, dentistry, etc., requires education and training *beyond* the bachelor's degree; *i.e.*, it requires the PhD degree. In general, this means another five or six years of schooling --- but it is *not* costly. Almost all qualified students receive financial aid in the form of assistantships or fellowships.

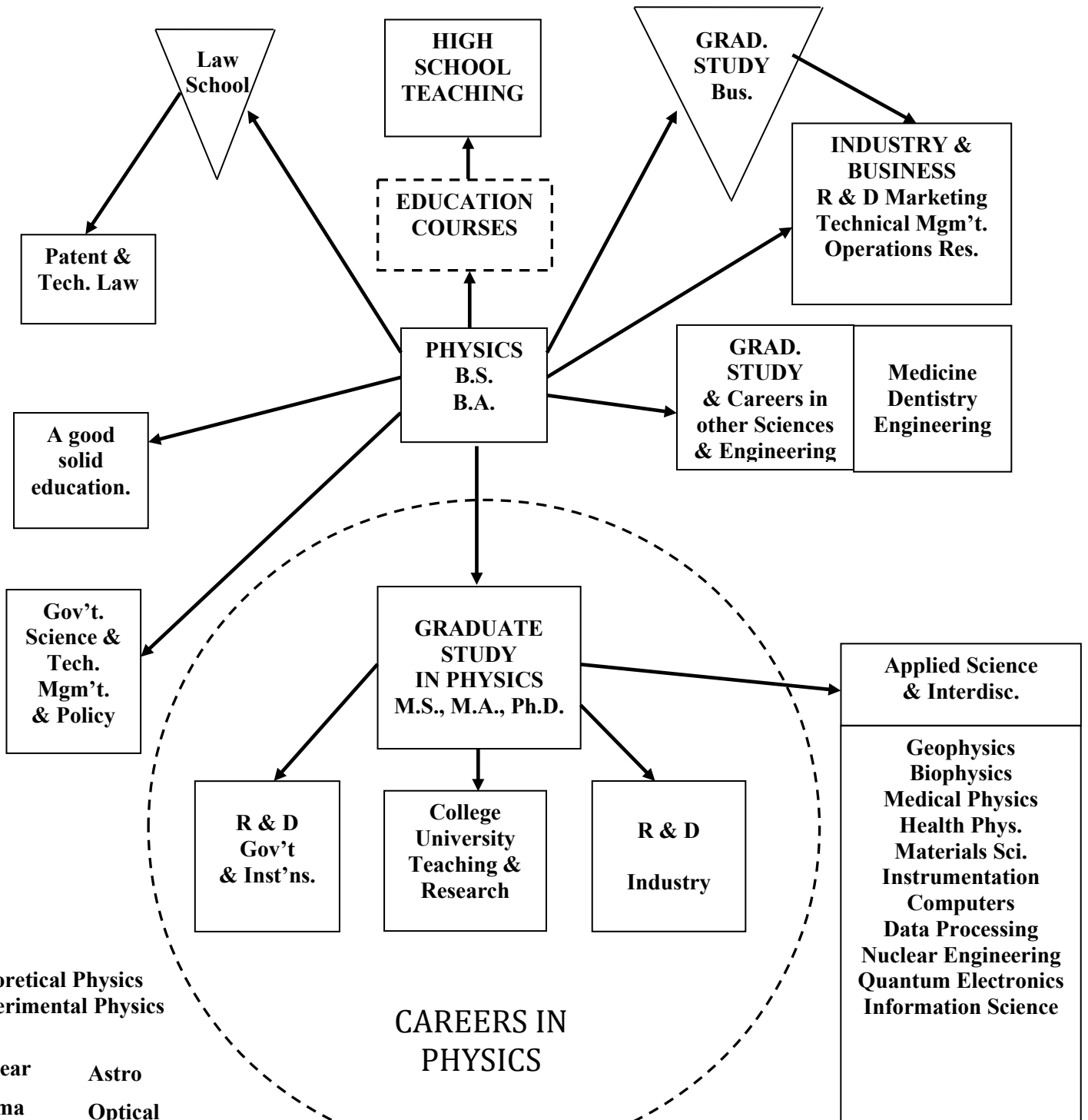
At Kent State University, graduate assistants who qualify receive a full tuition waiver and are paid nine-month stipends (\$18,540) during the academic year. Usually some support is also available during the summer. In return, the student must render service to the Physics Department as a *TA* (teaching assistant) or an *RA* (research assistant). Both responsibilities provide good experience for the student, and, as an *RA*, the student often works in his/her research area.

The flowchart on the next page outlines some of the career paths that are possible for someone with a bachelor's degree in physics. For new graduates at the bachelor level, there are fewer jobs in physics than, for example, in chemistry or engineering; however, there are also far fewer people competing for those jobs. Some of the industries that hire graduates with a bachelor's degree in physics include electrical/electronic; semiconductor; automotive; communications; aerospace; instrumentation; and materials. Some of these industries (*e.g.*, automotive) don't specifically advertise for physics graduates, but they do hire. Industries such as these are often interested in hiring graduates that can demonstrate a breadth of knowledge, and who have the ability to analyze and solve problems. These abilities are well-known to characterize graduates with training in physics.

The median annual wage of physicists was \$120,950 in May 2018. The lowest 10% earned less than \$59,300, and the highest 10% earned more than \$193,280.

[Source: **Occupational Outlook Handbook**].

FLOW CHART (Careers in Physics)



Theoretical Physics
Experimental Physics

Nuclear Astro
Plasma Optical
Chemical Low Temperature
Solid State Liquid Crystal
Space Semiconductor etc.

Most professional physicists are members of one of the component societies of the *American Institute of Physics* (AIP). These societies include the following: The American Physical Society; The Optical Society of America; The Acoustical Society of America; The Society of Rheology; The American Association of Physics Teachers; The American Crystallographic Association; The American Astronomical Society; The American Association of Physicists in Medicine; The American Vacuum Society; and The American Geophysical Union.

The American Physical Society has produced *CareerPlus*, a career and employment guide for physicists just entering the job market, as well as for those in midcareer. The guide can be accessed on the World Wide Web at <https://www.aps.org> under the "Careers in Physics" button.

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<https://www.kent.edu/physics>