

Undergraduate Physics Majors Handbook



2022–2023

University of Wisconsin-Madison
Department of Physics
www.physics.wisc.edu



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Looking for a Physics Club?
Check out the UPS (University
Physics Society) located in 2328
Chamberlin Hall or find
information on page 28.

Web:
[https://win.wisc.edu/organization
/physicsclub](https://win.wisc.edu/organization/physicsclub)

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WELCOME

Welcome to the UW-Madison Department of Physics!

We have a long history of providing our students with a great educational experience. That experience will increase your understanding of the physical universe and provide you with the foundation for your future career. Expect hard work that pays big dividends.

If you have concerns about your studies in the department, you should discuss them with the faculty member in charge of the course you are interested in, or with the teaching assistant who has responsibility for the discussion or laboratory to which you are assigned.

Apart from purely academic matters, we are interested in your personal well-being. If there is anything you think we can help with, contact the department office, or email: info@physics.wisc.edu



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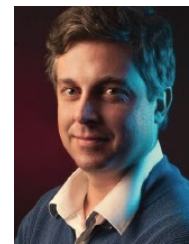
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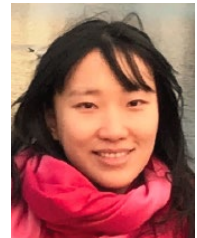
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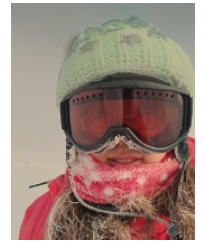
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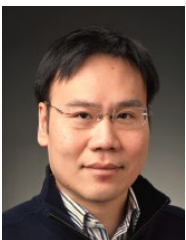
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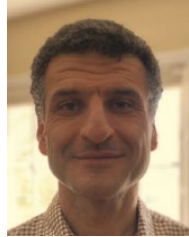
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UNDERGRADUATE PHYSICS PROGRAM

Roughly speaking, Physics is to the inanimate world what philosophy is to the patterns of human thought. We observe, describe, categorize, synthesize, and abstract. At one time, in fact, Physics was natural philosophy.

But in the modern era, the two have parted company. Science moved away from the guidance of philosophers and adopted its own approach to truth, asserting that measurement is the precise form of questioning and that precise questioning is the beginning of understanding. Physics is the science of the properties of matter, radiation, and energy in all forms. As such, it is the most fundamental of the sciences. It provides the underlying framework for the other physical sciences and engineering and for understanding physical processes in biological and environmental sciences.

CHOOSE TO BE A PHYSICS MAJOR

Why Study Physics?

1. Intellectual Satisfaction.

First, and foremost, Physics satisfies our deep desire to understand how the universe works. Physics is interesting.

2. Intellectual Challenge.

By striving for fundamental understanding, the physicist accepts the challenge to move past a merely descriptive approach of our world and probes deeply into how and why it works.

3. Physics Produces New Technology.

Today's esoteric Physics research will become tomorrow's technological advances.

4. Technical Expertise.

Physicists exploit forefront technologies in their pursuits.

5. Flexibility.

In a fast-paced and changing world, it is much more important to have a broad substantive education than to be trained in a specific skill. We teach people how to think, and how to apply and extend what they know to new types of problems.

6. Physics is Analytical and Quantitative.

People who can reason analytically and quantitatively are essential for the success of almost any pursuit.

Options

A degree in Physics helps prepare you for employment in industry, research, government, and academia. A bachelor's degree from the undergraduate Physics program will provide an overall view of both classical and modern Physics along with problem-solving ability and the flexibility to continue learning. Your training can:

- Prepare you for employment in industrial or governmental laboratories.
- Prepare you for graduate studies for masters or doctoral degrees in experimental or theoretical Physics.
- Provide a broad background for further work in other sciences, such as materials sciences, aerospace, astronomy, computer science, geophysics, meteorology, radiology, medicine, biophysics, engineering, and environmental studies.
- Provide a science-oriented liberal education. This training can be useful in some areas of business administration, law, or other fields where a basic knowledge of science is useful.
- Provide part of the preparation you need to teach Physics. To teach Physics in high school, you will also take education courses to become certified. You will need a doctoral degree to become a college or university professor.



MAJORING IN PHYSICS

Helpful Hints

For the most up-to-date information:

UW Physics: physcs.wisc.edu

UW Guide:

guide.wisc.edu/undergraduate/letters-science/physics/

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As soon as a student decides, and before the end of the sophomore year, prospective Physics majors should discuss their plans and curriculum with the appropriate undergraduate advisor. A list of advisors is available on page 4 or from the Physics Department website. Students should consult the University of Wisconsin Guide page for the general requirements for BA and BS degrees.

TO DECLARE A PHYSICS MAJOR

You must declare your major by filling out a “major declaration form,” signed by a Physics Department Undergraduate Advisor. You should talk with one of the undergraduate advisors as soon as you know you might have an interest in the Physics major. Students can declare their Physics major at any time after completing their first Physics course on the UW-Madison campus, and we encourage doing this as early as possible. You must have a 2.5 GPA in physics and math courses taken at Madison at the time you declare. In all cases, the major must be declared before the semester in which you graduate. The form can be obtained from the front desk in the department office, located in 2320 Chamberlin Hall. You should bring a copy of your current course history when you talk with a Physics Department Undergraduate Advisor. Note: All L&S undergraduate students are required to declare a major or be admitted into a program before or upon the completion of 86 credits (including credits from transfer, AP, test, study abroad, or retroactive credits).

Engineering and Other Non-L&S Majors Seeking an “Additional Major” in Physics

An undergraduate in the College of Engineering or any college other than Letters and Science (L&S) needs to complete the Physics requirements for the Physics major; and the L&S residence and quality of work in the major requirements. None of the other requirements of the College of L&S need to be satisfied. Students majoring in any other program that is NOT in the L&S require a formal approval from the other college to declare the additional major in Physics. This process may delay declaring the major in Physics.

REQUIREMENTS

The requirement is a total of 35 credits. The 35 credits must include these four groups:

1. Introductory Requirements

First Course: Physics 247 (recommended) or 207 or 201 or (EMA 201 and either EMA 202 or ME 240)

Second Course: Physics 248 (recommended) or 208 or 202

Third Course: Physics 249 (recommended) or 205 or 235 or 241 or 244

Note: A maximum of 5 credits from EMA 201, EMA 202, and ME 240 count toward the 35 required. The introductory course sequence consists of three courses: Physics 247/Physics 248/Physics 249 in the honors sequence recommended for prospective physics majors, Physics 201/Physics 202/Physics 205 is recommended for engineers, and Physics 207/ Physics 208/Physics 241 is intended for life sciences and chemistry majors, and is suitable alternative for physics majors. Although we recommend following one of these sequences, it is allowed to mix them with the exception that transfers into the Physics 247/Physics 248/ Physics 249 honors sequence are not permitted.

2. Core Requirements

Mechanics: Physics 311

Electromagnetic Fields: Physics 322 or (ECE 220, 320 and 420)

Thermal Physics: Physics 415 or (CHEM 561 and 562) or ME 361

Quantum Physics: Physics 448 and 449 (recommended) or Physics 531

Note: A maximum of 3 credits from CHEM 561 and 562 apply toward the 35 required. A maximum of 3 credits from ECE 220 and ECE 320 and ECE 420 apply toward the 35 required.

3. Laboratory Requirements

All Physics majors must take 6 credits of intermediate and/or advanced lab.

Full registered credit per course: Physics 307, 407

Two credits applies for each of these courses: Physics 321, 325, 623, 625, NE 427, 428

One credit applies for each of these courses: ECE 305, 313

Note: We recommend starting with Physics 307, which includes a strong introduction to statistics and data analysis, but it is advantageous to wait until you have completed an introduction to Modern Physics. Physics 321 can be taken any time after completion of 202, 208 or 248. Physics 325 requires at least concurrent enrollment in Physics 322. Physics 407 requires completion of Physics 448 or 531. Non-course research experience is invaluable and very strongly encouraged, but seldom offers exposure to breadth of experimental techniques covered in Physics 407. Lab course credit for such exposure will be granted only in exceptional circumstances.

Note: For non-physics courses, students will receive only the credit applied as lab toward the 35 credit requirement.

Note: Non-physics lab courses not listed above may be considered for lab credit if approved by a physics advisor, but must cover substantially the same breadth and depth of experience as one of the physics lab courses.

4. Advanced Physics Electives

The remaining credits to total 35 must be from advanced level Physics courses (see "Level:" designation in the course description), or Physics 301. The Physics Department suggests that your program include the seminar on Physics Today (Physics 301).

Transition Notes

Note 1

Physics major declared prior to Fall 2015

If you declared a Physics major at UW-Madison before September 2, 2015, you will graduate under the old core requirement of Physics 311 and 322. There are other minor differences.

Please consult with an undergraduate Physics advisor.

Note 2

Took Physics 307, 308, or 407 Prior to August 1, 2011

If you have taken Physics 307, 308, or 407, OR declared a Physics major before August 1, 2011, you will graduate under the even older requirements of 32 credits of Physics, including 2 credits of intermediate/advanced lab (or 3 credits if you have taken Physics 249).

Note 3

Prior to Spring 2019
Physics 325 does not provide lab credits, and Physics 308 provides credits toward the laboratory requirement.

Questions regarding transition notes?

Please see an undergraduate Physics advisor.

L&S Residence and Quality of Work in the Major Requirements

- 2.000 GPA in all major and major subject (Physics) courses
- 2.000 GPA in all upper level work in the major. All courses that would count toward core, laboratory, and advanced Physics electives are included.
- 15 credits of upper level work in the major must be taken in residence. All courses that would count toward core, laboratory, and advanced Physics electives will count toward this requirement.

L&S Graduation Requirements

The University of Wisconsin College of Letters and Science also has curriculum requirements for the Bachelor of Arts and Bachelor of Science degrees:

- Foreign Language
BS - third-year level in high school, or equivalent.
BA - fourth level in one language, OR third level in one language and second level in another language.
- Communication (A & B)
- Quantitative Reasoning (A & B)
- Breadth Requirements Minimum 12 credits Humanities
Minimum 12 credits Social Science
Minimum 12 credits Natural Science
Minimum 3 credit Ethnic Studies
- Total Degree Credits: 120
- Liberal Arts and Science Credits: 108

SUGGESTED CURRICULUM

The appropriate program for a student's goals should be established with the help of the advisor. **For the introductory program**, Physics 247-248-249 is strongly recommended, but the listed substitutes are acceptable. Note, however, that Physics 247 is offered only in the fall semester. It is possible to enter the core program in either semester since 201, 202, 205, 207, 208, 235, 241, 311, and 322 are offered each semester.

Intermediate and Advanced Lab Courses

Students are encouraged, but not required, to take 307 after completing Physics 205, 235, 241, or 249. Physics 407 provides a lab experience closer to that of actual research, with more student initiative and less overall structure. This option should be seriously considered by those intending to go on to graduate school in Physics or who desire a broad and thorough background in laboratory work. Physics 407 can be taken for two or four credits, but consent of instructor is required to take it without first having 307. Please note that due to enrollment pressure, the 4-credit option is often not available.

Physics 321 provides experience in electronics and is useful, but not required, preparation for the other laboratory courses. 321 is a four credit course, including two credits of intermediate laboratory that can be used toward fulfilling your laboratory requirement. Physics 623 provides similar experience at a significantly higher level, but has no additional pre-requisites. Physics 325 is a four credit course in optics, including two credits that count toward the lab requirement. Finally, Physics 625 is an advanced, four credit course in applied optics that includes two credits of advanced laboratory work. It can be taken by undergraduates who have completed Physics 322, but is more challenging than 325.

Mathematics

There are specific math courses listed as prerequisites for our Physics courses. Depending on your interest in math (some Physics majors also major in Math as well), the courses you select may be different. A typical math sequence is: Math 221, 222, 234, 319, (or Math 320 instead of 319/340), 321, 340, 322. Please consult with an advisor when choosing your Mathematics courses, particularly before deciding on one of the honors sequences in Math. We do not recommend the honors sequences for physics majors unless you are considering a second major in Math.

- **Math 221/222:** Standard Introductory calculus sequence. Math 221 is a prerequisite to Physics 247, 207, and 201.
- **Math 234:** Calculus of Several Variables, typically taken to complete the sequence Math 221/222/234. This course can be taken simultaneously with Math 319.
- **Math 319:** Techniques in Ordinary Differential Equations. You are strongly advised to take this and Math 340, or Math 320 before Physics 311 (Mechanics).

- **Math 340:** Elementary Matrix and Linear Algebra. This course is a bridge between concrete and abstract math. The next step for students interested in more abstract math is Math 521/522 (Advanced Calculus). Many Physics students find Math 340 to be particularly useful for Physics 311 and later for quantum mechanics and we strongly suggest taking it or Math 320. Math 320 is a "light" version of Math 319 and 340. It is adequate for the rest of our undergraduate physics curriculum, but is not recommended for those planning on continuing to graduate school. There is a special honors section, Math 320!, that thoroughly covers all of the material in 319 and 340. We recommend it as a good way to fit in both topics before you take Physics 311, but it is a more challenging course, and seems to be taught irregularly.
- **Math 321:** Applied Mathematical Analysis. Techniques for solving problems in the physical sciences, engineering, and applied mathematics, using advanced calculus and analytic function theory. It is recommended that Math 321 be taken before taking Physics 322. Math 321 is a highly recommended for physics majors, but requires a significant time commitment.
- **Math 322:** Applied Mathematical Analysis. Techniques for solving partial differential equations, with an emphasis on practical problems in the physical sciences. Also covers special functions, Fourier Transformations, etc. Math 321 and 322 are recommended for those planning to continue on to graduate school in Physics.

Chemistry

A college course in chemistry is advised for all Physics students. Courses in physical and organic chemistry are useful for Physics students. Organic chemistry is particularly valuable for those interested in biophysics or other life sciences.

Computing

Students are advised to learn the methods of scientific programming. The most useful courses would be in Python or C and C++.

Degree Audit Reporting System (DARS)

The Degree Audit Reporting System (DARS) is part of UW-Madison's commitment to academic advising for undergraduate students. A DARS report is particularly helpful when combined with the personal wisdom and insight of skilled advisors. DARS reports should always be reviewed with transcripts. This report becomes increasingly important as a student first decides on a particular college, then determines a particular major or combination of majors, and finally approaches graduation. DARS shows which requirements have already been completed and which remain unsatisfied. The report can offer suggestions about appropriate courses that may be taken to meet specific requirements. DARS is not intended to replace student contact with academic advisors. Students should print their DARS report through their MyUW. DARS may be helpful in showing how completed or in-progress courses may be used in different degree programs.

<https://registrar.wisc.edu/dars/>

RECOMMENDED PROGRAM

Suggested Program for Physics Majors – Starting Physics in the Fall of First Year

	Fall	Spring	Comments:
Year 1	<u>PHY 247</u> (5 cr)*	<u>PHY 248</u> (5 cr)	
	Math 222	Math 234	
Year 2	<u>PHY 249</u> (4 cr)	<u>Physics 311</u> (3 cr)	Instead of Math 320!, students can take Math 319 and Math 340
	Math 320!	Physics 307 (2 cr)	
	<u>PHY 321</u> (4 cr)	Physics 301 (1 cr) **	
		Math 321	
Year 3	<u>PHY 322</u> (3 cr)	PHY 323 (3 cr)	
	Math 322	<u>PHY 415</u> (3 cr)	
Year 4	<u>PHY 448</u> (3 cr)	PHY 407 (2 or 4)	Due to enrollment pressure in PHY 407, the 4 credit option is often not available
		<u>PHY 449</u> (3)	
		Electives	

Accelerated program: Students entering with Math 222 credit can move Math 234, 319, 321 and Physics 311– 322 sequences up by one semester, and Physics 448–449 to the third year. (Physics 407 lab can be delayed to the fourth year.)

The underlined courses are the “Physics Core Program.” The senior year could include electives, such as 525, Introduction to Plasmas; 535, Introduction to Particle Physics; 551, Solid State Physics; 623, Electronics ; or 625, Applied Optics.

* Some students take Physics 115 in their first semester to see if they really want to go into Physics.

** Physics 301, Physics Today, is an introduction to modern fields of Physics research and, with permission, can be taken more than once (though counted only once toward the 30 credits requirement in Physics). It may also be attended as a colloquium series with no registration, credit, or requirements.

Suggested Program for Physics Majors – Starting Physics in the Fall of Second Year

	Fall	Spring	Comments
Year 1	Math 221	Math 222	
Year 2	PHY 247 [5]	PHY 248 [5]	Can take Math 320! instead of Math 319 + Math 340
	Math 234	Math 340	
	Math 319	PHY 301 [1]	
Year 3	PHY 249 [4]	PHY 322 [3]	PHY 415, PHY 325 can be taken in Y3 (or Y4) Spring
	PHY 311 [3]	PHY 307 [2]	
	Math 321		
Year 4	PHY 415 [3]	PHY 449 [3]	Alternatives: 1. PHY 321 (Y4 Fall) and PHY 325 (Y4 Spring) (instead of PHY 407) 2. Both PHY 325 & 2 credits PHY 407 (Y4 Spring) and no PHY321 3. PHY 325 could also be taken in Y3 Spring
	PHY 448 [3]	PHY 407 [2]	
	PHY 321 [2+2]		

RECOMMENDED PROGRAM

Suggested Program for Physics Majors – Starting Physics in the Spring of the First Year

	Spring	Fall	Comments:
Year 1	<u>Math 221</u>	<u>PHY 207</u> (5 cr)	
		Math 222	
Year 2	<u>PHY 208</u> (5 cr)	<u>PHY 241</u> (3 cr)	1. PHY 321 can be taken 2 nd or 3 rd year. 2. Can take Math 319 + Math 340 instead of Math 320!
	<u>PHY 321</u> (4 cr)	<u>PHY 301</u> **	
	Math 234	Math 320!	
Year 3	<u>PHY 311</u> (3 cr)	<u>PHY 322</u> (3 cr)	Math 340 if you did not take Math 320!
	<u>PHY 307</u>	<u>PHY 325</u> (3 cr)	
	<u>Math 321</u>	<u>Math 322</u>	
		<u>Math 340</u>	
Year 4	<u>Physics 415</u> (3 cr)	<u>PHY 449</u> (3 cr)	Due to enrollment pressure in PHY 407, the 4 credit option is often not available
	<u>Physics 448</u> (3 cr)	PHY 407 (2 or 4 cr)	
	Electives		

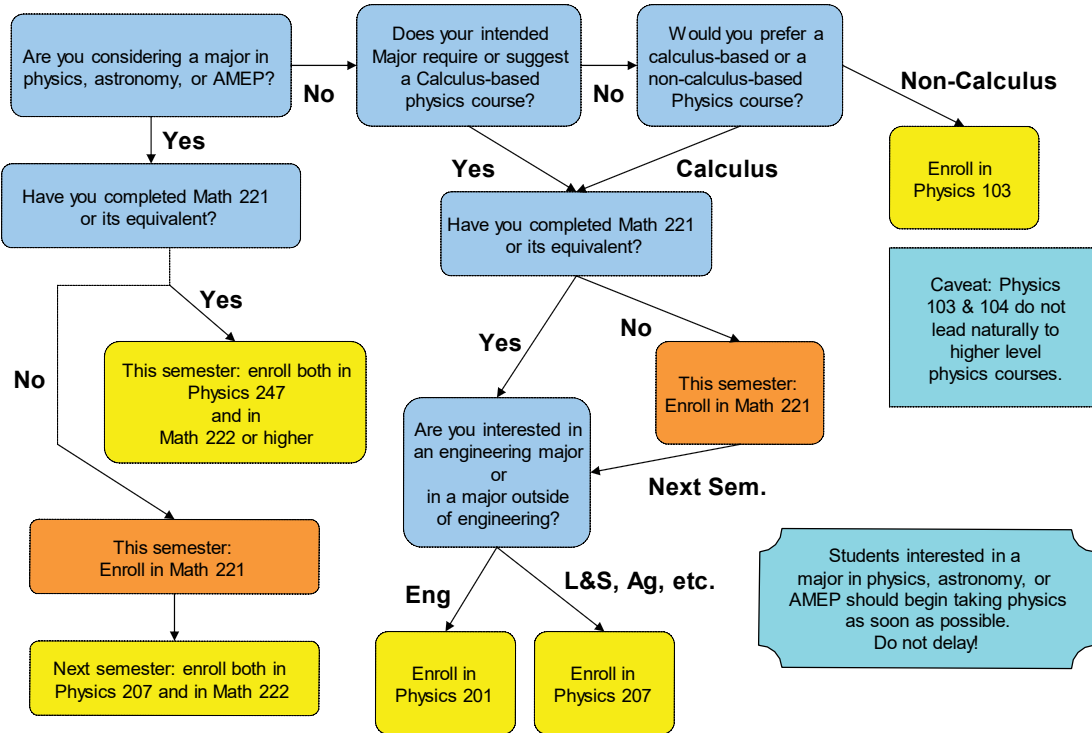
The underlined courses are the “Physics Core Program.” The senior year could include electives, such as 525, Introduction to Plasmas; 535, Introduction to Particle Physics; 551, Solid State Physics; 623, Electronics ; or 625, Applied Optics.

* Some students take Physics 115 in their first semester to see if they really want to go into Physics .

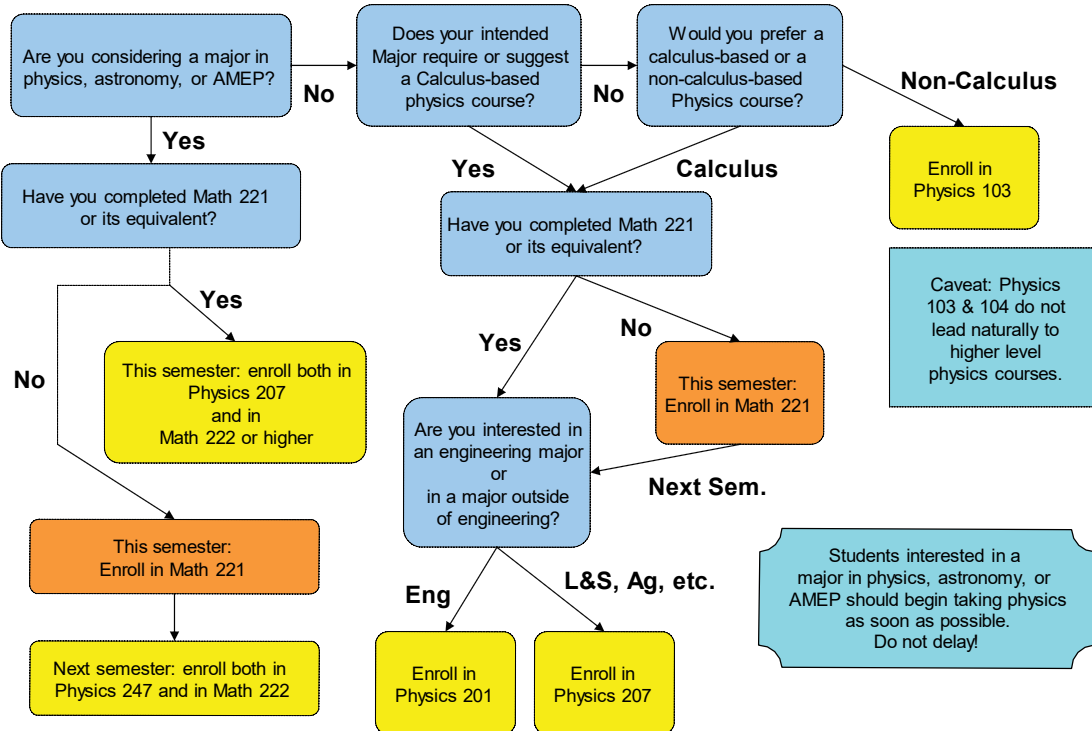
** Physics 301, Physics Today, is an introduction to modern fields of Physics research and, with permission, can be taken more than once (though counted only once toward the 30 credits requirement in Physics). It may also be attended as a colloquium series with no registration, credit, or requirements.

INTRODUCTORY PHYSICS COURSE SELECTION FLOW CHARTS

Choosing an Introductory Physics Course in the Fall Semester



Choosing an Introductory Physics Course in the Spring Semester





GRADE CHANGES & INCOMPLETES

POLICY ON CHANGE OF GRADE

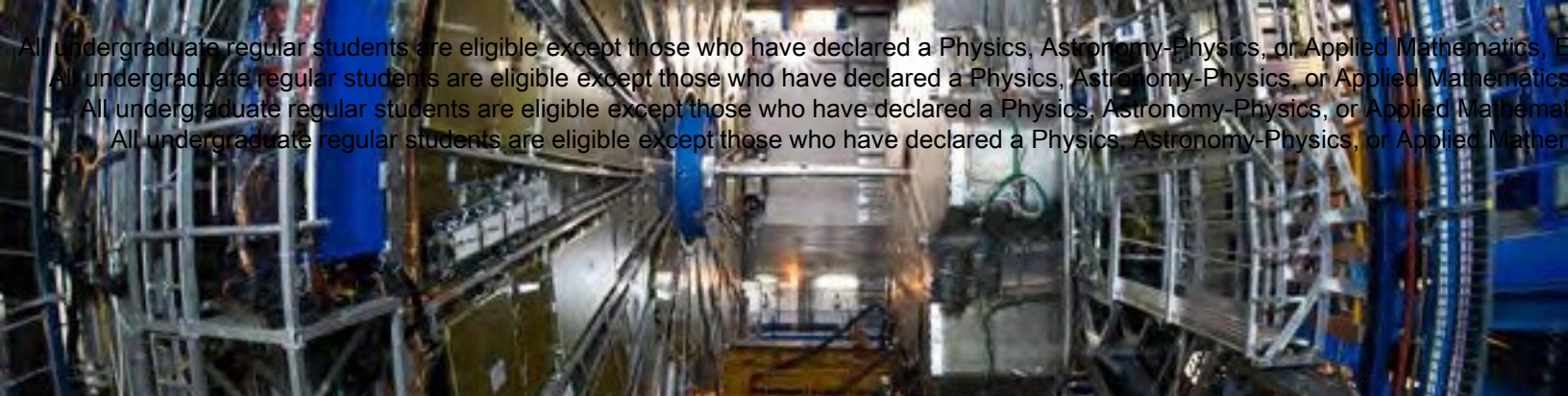
Extra work to improve a final grade is not allowed. Faculty legislation states that final grades can be changed only because of clerical error. To dispute the accuracy of the grade, first contact the professor/instructor of the course. A student who disputes the accuracy of a final course grade and who does not find satisfaction by informal approaches to the instructor may appeal to the department chair.

1. The appeal must be made within the first four weeks of the semester following the grading.
2. The appeal must be submitted in writing to the Department Chair, Mark Eriksson, and the Instructional Program Coordinator, Mark Rzechowski.
3. The Department Chair, or a delegate of the Chair, will request a written summary of the instructor's case. The student may also be asked to submit a further written response.
4. The Department Chair will make a final disposition of the appeal at the Department level by:
 - a. rejecting the appeal;
 - b. recommending that the instructor change the grade;
 - c. prescribing a further examination or submission of work which the Department Chair finds is required to remove any ambiguities in the previous evaluation of academic performance. This may result in a meeting with the Department Chair, the instructor, and the student.

Note: The decision to change a grade is ultimately up to the instructor, and the Department Chair cannot make a change to the grade. The decision of the Department will be communicated to the student in writing.

POLICY ON INCOMPLETES

An Incomplete may be reported for a student who has carried a subject with a passing grade until near the end of the semester and because of a substantiated cause has been unable to complete the course. An incomplete must be completed by the end of the fourth week of classes of the student's next semester of residence at the University (exclusive of summer sessions) or it will lapse into a Failure.



DEGREE OPTIONS

The Department of Physics offers students several different options for majoring or minoring in Physics. There are both a BA and BS degree for Physics Majors. Students can earn a BA or BS with Honors or take certain Physics courses for honors credit (see page 21). There is also a Certificate in Physics available.

Students can earn a major in Astronomy-Physics through the Department of Astronomy (see page 22) Also, the AMEP major is a specialized four-year program in interdisciplinary physical sciences of applied math, engineering, and physics (see page 23). Finally, the School of Education offers a Physics major for secondary education.

CERTIFICATE IN PHYSICS (CERT 783)

The department offers an undergraduate certificate in Physics. An understanding of the physical universe informs many disciplines. The study of Physics is essential to understanding nature and to advancing technology in the coming century. A certificate in Physics increases the opportunities for students to become better informed on technological issues at the local, state, national, and international levels.

The certificate (18 credits) is designed to serve undergraduates majoring in biology, chemistry, mathematics, engineering, education and other fields who wish to extend their study of Physics beyond what may be required or recommended for their major without completing the full L&S Physics major requirements (35 credits including 6 intermediate/advanced lab credits).

The Certificate Requirements

To earn a certificate in Physics, a student must complete at least 18 credits in Physics courses at the “intermediate” level or higher. Graduate-level courses are permitted on a case by case basis. No more than 3 credits of independent study and no special topics courses may be used to satisfy this requirement. Transfer or AP credit for 200-level introductory Physics is acceptable for meeting the requirements of the certificate. EMA 201 and EMA 202 or EMA 201 and ME 240 may be substituted for Physics 201 and together count for 5 credits. Otherwise, only courses within the department (or cross-listed with Physics) are acceptable. Only one course from each of the three semesters of introductory Physics can be counted.

TO DECLARE A PHYSICS CERTIFICATE

To declare a certificate in Physics you must fill out a major/certificate declaration form. An Undergraduate Physics Advisor must sign the form. Students can declare the Physics certificate at any time after completing one Physics course on the Madison campus. In all cases, the certificate must be declared before the semester in which you graduate.

The form to declare the certificate can be obtained at the department office in 2320 Chamberlin Hall.

Note: You should bring a copy of your current course history (not DARS) when you talk with the undergraduate advisor.

1. All undergraduate regular students are eligible except those who have declared a Physics, Astronomy-Physics, or Applied Mathematics, Engineering, and Physics (AMEP) major.
2. The certificate will be awarded upon graduation if requirements have been completed and the certificate declared by then
3. At least nine credits must be in residence.
4. Only graded courses may be used toward the certificate.
5. A minimum grade point average of 2.0 is required for courses used toward the certificate.

HONORS IN THE MAJOR—PHYSICS

Students wishing to earn BA or BS with Honors in Physics must speak with an undergraduate advisor in Physics. You must also complete the Honors in the Major declaration form available in the Honors Program office (Washburn Observatory). Please note that the Honors in the Major declaration form is NOT the same as the major declaration form used to declare a major in Physics.

Students may declare Honors in this Major in consultation with their Major Advisor. To earn Honors in the Major, students must take the same introductory, core, and lab courses as the standard major plus meet these additional requirements:

1. 3.300 University GPA
2. 3.300 GPA in all major and major subject (Physics) courses
3. Senior Honors Thesis: Physics 681 and 682 for 6 credits
4. 12 honors credits in courses used to satisfy the requirements, with at least 9 at the advanced level

HONORS IN PHYSICS COURSES

Many Physics courses can be taken for general honors program credit, as indicated in the timetable. You must speak with the faculty member teaching the course. You can then add honors through the on-line student center.

Helpful Hints

For the most up-to-date information on the Astronomy-Physics major, please consult the university web site or contact the Astronomy department:

Astronomy

608-262-3071

2535 Sterling Hall
475 North Charter Street
Madison, WI 53706

Astronomy Web:
www.astro.wisc.edu

UW Guide:

<https://guide.wisc.edu/undergraduate/letters-science/astronomy/>

Astronomy-Physics Advisors

Prof. D'Onghia

3504 Sterling Hall
edonghia@astro.wisc.edu

Prof. Stanimirovic

4514 Sterling Hall
sstanimi@astro.wisc.edu

Eric Scheffner

803 Atmospheric Oceanic Space Sci
elschueffner@wisc.edu

THE ASTRONOMY–PHYSICS MAJOR

Astronomy, the oldest of the sciences, for the last several decades has been one of the most exciting fields of modern scientific research. New discoveries concerning the solar system, stars, galaxies, and the origin of the universe continue to be made by both ground and space telescopes.

To understand and pursue modern astronomy, one must have a solid background in Physics and mathematics as well as in astronomy.

The astronomy-physics major, administered by the Dept. of Astronomy, provides undergraduates the opportunity to appreciate our current understanding of the astronomical universe, while developing the necessary Physics and math background. Students who intend to continue astronomy in a graduate program are strongly encouraged to do a Senior Thesis (Astro 681/682 (honors) or Astro 691/692). The experiences of research and of writing a major paper develop both technical and writing skills.

AMEP: APPLIED MATHEMATICS, ENGINEERING & PHYSICS

What is AMEP?

Applied Mathematics, Engineering, and Physics (AMEP) is an interdisciplinary bachelor of science degree program focusing on math, physics, and an area of engineering. Despite its demanding curricula, AMEP is designed to be completed in four years.

Why AMEP?

AMEP provides solid, interdisciplinary foundations for students interested in academic and industrial careers in engineering and the sciences. Program graduates consistently land coveted spots in well-ranked graduate programs and on the tech and science job markets.

AMEP is for the student who is very interested in mathematics, physics and engineering but does not want to specialize too early into any one of those directions. AMEP tries to achieve an optimum balance of breadth and depth.

AMEP offers a unique combination of mathematical physics and engineering education that not only provides excellent preparation for graduate school in applied science or engineering, but is also of great value to industry. AMEP students interact with Mathematicians, Physicists and Engineers throughout their education and this leaves them well equipped to contribute to interdisciplinary teams and to adapt to complex and changing situations and technologies.

Please visit the Opportunities page, <https://www.math.wisc.edu/amep/opportunities>, to learn more about scholarships, research, and internship opportunities for AMEP students.

How is the AMEP program different?

The AMEP program is challenging and demanding. It is a program recommended only for those students who have strong ability and great interest in mathematics and physical science. An incoming AMEP student must have had sufficient preparation from high school to begin with calculus, chemistry and physics in his or her freshman year.

The AMEP program has specific graduation requirements which are different from those for a typical BS or BA degree. AMEP requires a minimum of 21 engineering credits forming a coherent concentration of courses into an engineering field.

AMEP Physics Advisors

Prof. Cary Forest

3277 Chamberlin Hall
Tel: 608.263.0486
cbforest@wisc.edu

Prof. Robert McDermott

5112 Chamberlin Hall
Tel: 608.263.4476
rjmcdermott@wisc.edu

Prof. Thad Walker

5322 Chamberlin Hall
Tel: 608.262.4093
tgwalker@wisc.edu

Prof. Deniz Yavuz

5320 Chamberlin Hall
Tel: 608.263.9399
yavuz@wisc.edu

AMEP-advisors@wisc.edu

AMEP Program

Department of Mathematics

203 Van Vleck Hall
480 Lincoln Drive
Madison WI 53706-1388
Tel: 608 263 2546

Web: <http://www.math.wisc.edu/~amep>

Committee-in-Charge: Professors Yavuz (Physics), and Waleffe (Mathematics, Engineering Physics)

Advising

Each student will have three faculty advisors: A degree advisor, who is a Professor in the Department of Mathematics; a Physics advisor, who is a Professor in the Department of Physics; and an engineering advisor, who is a Professor in the department in which the student focuses.

Credits

AMEP requires a total of a least 125 credits in the College of Letters and Sciences and/or the College of Engineering.

This four-year degree program in the interdisciplinary physical sciences offers a strong theoretical foundation in related areas of engineering sciences, mathematics, and physics for professional work in the field of industrial research and technology. It also provides a foundation for graduate degree work in applied mathematics, engineering sciences, and physics.

The AMEP program is an excellent choice for the student with broad interests in mathematics, physics and engineering. AMEP emphasizes an integrated mathematics and physics curriculum and strives to achieve an optimum balance of breadth and depth in the physical sciences within the confines of a 4-year degree.

Requirements for the BS-AMEP degree are listed in the University of Wisconsin-Madison, Guide. Please see the Applied Mathematics, Engineering, and Physics, B.S. AMEP page for up to date information:

<https://guide.wisc.edu/undergraduate/letters-science/mathematics/applied-mathematics-engineering-physics-bs-amep/>



RESEARCH EXPERIENCE

Web Site

- **For More Information**
www.physics.wisc.edu/resources/employment/student-jobs

WHY?

The Physics department considers direct experience with ongoing research to be one of the most important parts of a Physics major's education.

From your perspective, there are two major reasons for this:

1. It is a good way to find out what working in Physics is actually like, and whether it's something you really want to do or not. It's an entirely different experience than classes.
2. If you end up applying to graduate school (and many of our majors end up doing this even though they weren't considering it when they started out), the current expectation of admissions committees is that you will have real research experience and a letter of recommendation to go with it. Letters from professors you've just taken a course or two with are much less useful.

WHAT'S INVOLVED?

Most research groups in the department are run by a single professor and may involve a postdoc, several graduate students, and in many cases, some undergraduates. Some groups are larger and have several professors collaborating on a single project. Most of the groups have websites that tell a little about what they are doing. You can locate these through <http://www.physics.wisc.edu/research/groups>, and a list of faculty by research area can be found on page 6 in this handbook. Working with one of these groups involves a serious time commitment: they will generally expect a minimum of 10-15 hours a week on the average. Less than this results in little benefit for either you or the research group. However, the scheduling is usually flexible — you can work less around midterms and finals and make up for it at other times, and in many cases you can do some of your work evenings or weekends or when it fits your schedule better. Most research groups pay normal hourly rates for the time you put in. Some are on tight budgets and you may improve your chances of getting in if you let it be known you're willing to volunteer.

WHEN?

Sooner is usually better. The more time you spend with a research group, the more you'll know about how they do things, and the more responsible and interesting jobs you'll be able to take on. If you are taking Physics 248, you should be thinking about getting involved in research. For most research jobs, there is not a course work requirement; you're going to learn what you need to know on the job. Most groups are not interested in taking on seniors because they won't be around long enough to get useful.

HOW?

Look on the websites referred to above and see what looks interesting to you. Talk to the professors in your classes and to other majors in the Physics Club. Do your homework: read up on what someone is doing before you go to talk with them. Ask them if they would tell you more about it, and let them know you're interested in getting involved. Above all, be persistent! The UW Honors program has good opportunities for sophomore summer research support, and the Hilldale program has a competition for Juniors and Seniors that includes a paid stipend. The National Science Foundation funds Research Experience for Undergraduate (REU) programs at many universities around the country. These are really intended for students from small schools that cannot offer their own research opportunities. For you, it is usually better to work with an on-campus group over the summer, so you can continue during the academic year. But if you see a group offering something you are really interested in, these programs do sometimes take UW students.

There are occasional opportunities to do research in another country. We strongly support the benefits of broadening your education with a semester or year abroad in one of the many excellent programs offered by the university. Doing this and still finishing your Physics degree in four years is possible, but requires careful planning, so be sure to talk with an advisor early on.



THE PHYSICS CLUB (UPS)

Helpful Info.:

University Physical Society
2328 Chamberlin Hall

Web:
<https://win.wisc.edu/organization/physicsclub>

E-mail: ups.officers@gmail.com

To Join...

Drop by Room 2328 Chamberlin Hall or email ups.officers@gmail.com to get a membership form. Hand in your completed membership form and your annual dues to a UPS Officer, and you are all set!

The University Physical Society (UPS)—also known as the Physics Club—is a student organization for people interested in Physics and related fields.

What does the Physics Club do?

The Physics Club organizes events such as seminars, tours, trips, and socials for its members. Physics Club volunteers also offer free drop-in tutoring to students in introductory Physics and astronomy classes. In addition, we maintain subscriptions to science related magazines which are kept in the club's room (2328 Chamberlin Hall) for students to read at their leisure.

Every Friday afternoon, we meet with the Physics colloquium speaker for half an hour, so we can learn about the process of becoming a scientist.

The club also sponsors a variety of other events. For example, in the past, we took a trip down to Fermilab and sponsored a racquetball tournament. Who knows what we'll come up with this year? If you have any good ideas feel free to suggest something!

Why should you join the Physics Club?

By joining the Physics Club you will be meeting other Physics majors, who are, in general, really cool people to hang out with. If you are thinking about declaring a Physics major, this is the place to come for helpful advice about taking classes and getting a job in the Physics department. You will feel very welcome here! We like to meet all sorts of people. Members of the UPS are laid back individuals and nobody should feel intimidated about approaching us.

Perks of being a Physics Club Member

When you join the Physics club, you get access to a newly renovated, excellent room, 2328 Chamberlin Hall. This room contains a refrigerator, reference shelves of textbooks, couches, tables, and chairs, blackboards, and a microwave. We have several computers in the room, as well as wireless access for your own laptop. You can get your own key to the room and come visit at your leisure and stay as long as you like. Plus, you get the added bonus of knowing people that are in your classes (Yay! Study partners!).

Some of the Things We Do

There are organized and planned events such as, field trips to research facilities both inside and outside of UW, for example Fermilab, Argonne National Lab, Madison Plasma Tours, and UW Nuclear Accelerator.

In addition, there are random, non-educational activities to get to know each other better. Activities include, ice cream socials, pizza parties, ice skating, movie night, card playing, pool, bowling, and more.

Every week at selected times, there are tutors if you have class related questions. UPS members are tutors, so if you would like to get involved please e-mail the officers.

Joining UPS adds you to the club e-mail list, so you will be notified about club sponsored events.



PEER MENTORING

Helpful Hints:

For more information, contact:

Physics Learning Center
2337/2338 Chamberlin

Susan Nossal
nossal@physics.wisc.edu
Tel: 262.9107

The Physics Learning Center (PLC) has job opportunities for physics undergraduates as Peer Mentor Tutors (PMT). The PLC is looking for PMTs who have a desire to help others learn physics and have an enthusiasm for learning new ways to solve physics problems.

The PLC provides supplemental instruction and a supportive learning environment to students in large challenging introductory physics courses. They include algebra-based Physics 103-104 and calculus-based 207-208 that are requisites for many STEM majors and pre-health professional pathways. The majority of students in these classes are not physics majors.

PMTs lead a learning team twice a week helping students build a conceptual framework to solve a variety of physics problems. The PLC strives to create a supportive learning environment to help students gain skills, increase confidence, and meet potential study partners.

Peer Mentor Tutors receive extensive training in teaching Physics and in general pedagogy. Tutors meet with a PLC staff member each week to discuss strategies for teaching course content, including how to use teaching materials that stress conceptual understanding. In addition, PMTs from all courses meet as a group for a weekly teaching seminar to discuss issues such as group dynamics, techniques for actively involving students in learning, helping students to prepare for exams, raising awareness of diversity in student experiences, resources on campus, etc.

Our Peer Mentor Tutors report that they greatly enjoy working with their students. In the process, they strengthen their own foundation in Physics and presentation skills. They also tell us that teaching Physics helps to review for the Graduate Record Exam and to prepare for post-graduate teaching in middle/high school or as a University teaching assistant.

PMTs are a mix of students majoring in physics, astrophysics, secondary science education, and engineering as well as from other majors. This is a paid position taking about eight hours per week that includes learning team time, content and pedagogy meetings, reviews before exams, and time to prepare for teaching.

To find out more about the PLC Peer Mentor Tutor Program, please Chamberlin. contact us. The PLC is located in 2337/2338

UNDERGRADUATE STUDENT AWARDS

For More information

For more information go to
www.physics.wisc.edu/awards

Or contact the department of Physics:
info@physics.wisc.edu

Application Process

The deadline for student applications for all awards is March 1. All application materials will need to be submitted via the on-line system by 4:00 pm on or before March 1. No late applications will be accepted .

To Apply

Please submit a statement of interest and how this award would help your education . If it is an award that is for financial need (Crabtree and Firminhac), you need to emphasize what the need is. If the award you are applying for also has a merit requirement, the department will run your transcript .

The Fay Ajzenberg-Selove Award is presented to undergraduate women majoring in Physics, Astronomy, or Physics/Astronomy for the purpose of encouraging women to continue their careers in science. Dr. Ajzenberg-Selove, who received her Ph.D. in Physics in 1952, is currently a Professor Emerita the University of Pennsylvania.

The Dr. Maritza Irene Stapanian Crabtree Award in Physics was established by William Crabtree to honor his wife, Dr. Maritza Crabtree, who graduated with a Physics degree in 1971. This annual award benefits undergraduate students in Physics based equally on merit and need.

The Bernice Durand Undergraduate Research Scholarship was established by Vice Provost/Physics Professor Bernice Durand to promote meaningful undergraduate research opportunities and to support and encourage women and ethnic minorities as undergraduate majors in the Departments of Physics and Astronomy.

The Henry and Eleanor Firminhac Physics Undergraduate Scholarship is given to undergraduates in Physics with financial need as the primary consideration. Funding provided by Ralph Firminhac in honor of his parents.

The L.R. Ingersoll Prize is given for distinguished achievement in introductory Physics. This prize is underwritten by a fund established by the family and friends of the late Professor Ingersoll, a distinguished physicist and teacher at the University who served as Department Chair for many years .

The Liebenberg Family Research Scholarship is for Physics, AMEP, or Astronomy/Physics majors. This scholarship opportunity was initiated by the Liebenberg family for the purpose of promoting undergraduate summer research opportunities.

The Albert Augustus Radtke Scholarship Award is given to outstanding junior or senior students majoring in Physics or Applied Mathematics Engineering and Physics. This award was made possible by a bequest of the late Mrs. Elizabeth S. Radtke in honor of her husband, a 1900 degree recipient from UW-Madison.



COLLOQUIA & SEMINARS

The Physics Department hosts a large number of colloquia and seminars each year. Check out the web for Colloquium & Seminar notices:
www.physics.wisc.edu/twap/

Undergrads are sometimes shy about attending events they see advertised in the departmental weekly calendar. Don't be—the seminars and colloquia are open events that you are welcome to attend. The percentage of a talk that you will understand varies widely from one seminar to another, and from one speaker to another. If you can understand the title and it sounds interesting, then there is a fair chance you will be able to keep up for a while. (Keep in mind that many people there will not generally follow the whole talk.)

The Physics Colloquium on Friday afternoon is intended to be a broad-based presentation that physicists in all subfields will enjoy. When it adheres to that ideal, it is often accessible to undergrads.

The Astronomy Colloquium on Tuesday afternoon is often understandable. There is also the Astronomy Journal Club, usually given by grad students in astronomy and astrophysics at noon on Thursdays—sometimes straightforward. The Astrophysics Seminar on Thursday afternoons begins with a social period, proceeds to a talk which is addressed to a group with widely varying interests, and encourages questioning the speaker. It is meant to be a place where those with astrophysical interests at all levels of experience can find a supportive interaction.

Most of the other topical seminars are usually very detailed talks for specialists in the fields, but if you watch the announcements you'll occasionally find one in which a speaker from outside the field is giving a more general talk. These can be quite interesting. Actually, the Chaos and Complex Systems Seminar at noon on Tuesdays often has interesting and understandable sounding titles. The other topical seminars are: Plasma Physics, Medical Physics, High Energy Physics, Theoretical Physics, Atomic Physics, Nuclear Physics, and Solid State Physics.

QUICK NOTES

Seminar & Colloquium Notices

- www.physics.wisc.edu/twap/

Physics Colloquia

- 3:30 PM on Fridays 2241 Chamberlin Hall, Fall and Spring semesters

Undergrad Colloquium

- Physics 301, Spring semester only

Related Colloquia & Seminars

www.physics.wisc.edu/twap/

- Astronomy Colloquium
- Chaos & Complex Systems
- High Energy Physics
- NPAC (Nuclear/Particle/Astro/Cosmo) Forums
- Plasma Physics (Physics/ECE/NE 922) Seminar
- R.G. Herb Materials Physics Seminar
- String Theory Seminar
- Theory/Phenomenology Seminar
- UW College of Engineering

Academic Year Seminars & Colloquia

- **Seminar & Colloquium Notices**

Check out the website for the current seminar and colloquium schedule www.physics.wisc.edu/twap/

- **Spring Semester**

The Undergrad Colloquium, Physics 301 In principle this is something similar to the Intro Seminar above, but it differs in several ways. It is pitched at undergrads directly. It consists of individual faculty talking about recent developments in their fields, as well as what is happening here, or being done by them. It is not a group effort as the intro seminar is, and it is not an advertisement to attract grad students to the group. It tends to try to be more educational.

Other Physics Related Events

- **Physics Major Fair: Fall**
- **APS Conferences for Undergraduate Women in Physics (CUWIP): Winter**
- **Undergraduate Graduation Reception for Graduating Seniors: Spring**

Special Lectures and Colloquia

- **Holiday (Spoof) Colloquium**—Friday in December
- **Physics Club Events**
Ice Cream, Trips and Tours, Pizza Meetings
Check with the club for the most recent info on coming events!
- **Wonders of Physics**—February
- **Physics Fair**—February

