# Elmhurst College

## PHYSICS 101 Physical Science

(http://www.elmhurst.edu/~earls/phy101)

**Spring Term, 2008** **Earl C. Swallow**

*Let us endeavor to see things as they are, and then enquire whether we ought to complain. Whether to see life as it is will give us much consolation, I know not; but the consolation which is drawn from truth, if any there be, is solid and durable; that which may be derived from error, must be, like its original, fallacious and fugitive.*

--Samuel Johnson

*It is a recurring experience of scientific progress that what was yesterday an object of study, of interest in its own right, becomes today something to be taken for granted, something understood and reliable, something known and familiar – a tool for further research and discovery.*

--J. Robert Oppenheimer

Physics 101 is a course designed to provide non-science majors with a basic understanding of the ideas, methods, philosophy, and significance of the physical sciences, particularly physics. Major emphasis is placed on material which can provide insight into the modern technological world. Some course material is drawn from astronomy and chemistry as well as physics, with considerable use of videotapes, films and field trips. **While this course is non-mathematical, the fundamentally quantitative nature of the physical sciences is a central element of it.** The primary requirement for success in this course is a willingness to pursue seriously the study of these profound and elegant ideas.

# GENERAL EDUCATION PROGRAM

Physics 101 is specifically intended for non-science students seeking to fulfill the **Inquiry and Issues in Science and Technology** requirement in the Elmhurst College General Education Program. Courses in this category develop knowledge of process and content in the natural sciences while emphasizing the impact of science on our world. They seek to raise students' awareness of the role played by science in the development of technology and of issues related to science and technology. By doing this they also foster responsible citizenship in an increasingly technological society. The four major objectives for this category are the following.

**(1) Development of critical thinking and problem solving skills through active exploration of natural science concepts and methods within a scientific discipline.**

This objective is consistently addressed by the exploratory laboratory work in combination with the concepts and principles developed in the text and in class. The historical emphasis of the class development and text also demonstrates the kinds of thinking and analysis which have given us these elegant ideas. These skills are strongly called into play by responsible consideration of societal issues like the impact of pseudoscience, global warming and ozone depletion.

**(2) Explicit identification and consideration of social, philosophical, and ethical questions associated with scientific and technological topics.**

This objective is addressed in the text, classroom, and videotape presentations. These considerations are woven throughout the course. These matters are often catalyzed by student questions, by margin quotations used throughout the text, by some of the short writing assignments during the term, and by term paper topics.

**(3) Recognition of the strength and power of scientific and technological knowledge as well as its limitations.**

A major theme of the text and course is the impact of scientific knowledge on how we view the world and our relationship to it. This is paralleled by discussion of the growth of scientific technology and its impacts on the daily realities of life. Discussion of measurement uncertainties ("errors") as a limiting aspect of experimental science begins early in the course. It then provides an important focus for a significant portion of the lab activities.

**(4) Internalization of scientific values such as intellectual integrity, curiosity, skepticism, tolerance for ambiguity, and openness to new ideas.**

These scientific values are variously addressed in three aspects of the course. First, they play a major role in the "story lines" dealing with the historical development of the physical ideas and theories examined in the course. Second, they are stressed in some of the videotapes used in the course. Short writing assignments and essay test questions reinforce these presentations. Third, scientific values are reinforced by the structure of the lab exercises.

## Across-the-Curriculum Emphases

Several Elmhurst College across-the-curriculum emphases are included in this course.

1. **Writing:** A variety of Writing Across the Curriculum (WAC) inspired formal and informal writing activities are an integral part of the course.

2. **Quantitative Reasoning:** Though this is a non-mathematical course (*i.e.*, students **do not** need to manipulate and solve algebraic equations or use advanced math), the text, lab, and course work do stress the use of numbers and numerical relationships in reasoning and analysis.

3. **Computer Literacy:** Students use computers to acquire, display, and analyze data in the lab. Course materials, assignments, and resources are available through a course Web site. This includes a page with an extensive collection of *science and society* links, including a comprehensive collection of materials that deal with identifying and exposing pseudoscience.

4. Many aspects of **technological literacy, problem solving, critical thinking,** and **values and ethics** are central to the description and objectives for this General Education Category as discussed above.

## Campus Involvement

This course is a General Education course which has been associated with the Common Experience Program. Some of you may be participats in the Common Experience Program. As we examine the development and impact of physical science, we will consider the importance of reliable evidence on the course of events. **To develop a broader context for your General Education experience, each of you will also be required to attend at least two campus intellectual events during the term.**

# COURSE GOALS

## Major Goals

1. To deepen your *appreciation* of "how science works"; how scientific concepts develop and are joined into theoretical structures; and, most important, how those structures are validated. A major aspect of this is learning what experimentation "really means."

2. To help you acquire *knowledge* of elementary-level physical science: first fundamental *concepts*, *relationships*, and *theories*, and secondarily, some basic facts about physical phenomena and

processes.

3. To promote the growth of *understanding*, so that you can analyze situations and use your knowledge of physical principles in making rational decisions.

4. To *relate* the knowledge and understanding which come from the study of physical science to other aspects of life.

5. To encourage critical *analytic thinking and logical reasoning*, both in the context of formal academic work and in "everyday" life.

6. To foster the *ability to learn independently*, increasing your capacity to acquire knowledge and understanding of new material on your own; for example, by reading books, magazines, newspapers, or periodicals.

7. To provide you with the *pleasure* and *satisfaction* which come from mastering parts of an elegant, powerful, and demanding intellectual discipline.

8. To make you aware of the attributes, methods, and outlooks which characterize the *scientific intellect*.

### Subsidiary Goals

1. To provide opportunities for *creative* use of the insights described above.

2. To encourage the self-understanding which comes from a deeper understanding of the physical universe of which we are each a part.

3. To permit you to fulfill one of the *requirements* for graduation.

## RESOURCES

To aid us in achieving these goals, a number of important resources are available.

### Texts

*Physics: Concepts and Connections* by Art Hobson; Prentice Hall, 4rd edition, 2007.

*Laboratory Manual for Liberal Arts Physics* by Art Hobson, Marie Baehr, and Earl C. Swallow; Prentice Hall, 2nd edition, 2007.

A list of useful related texts and references will be provided.

## Handouts

You are reading the first of several (helpful?) handouts which will be provided during the course.

## Personal Assistance

This course is (or should be) a cooperative undertaking involving you, your fellow students, and me. The **Learning Center** on the main floor of the Frick Center is also available to work with you. I am happy to provide help outside the classroom when needed. My email address is earls@elmhurst.edu, and my web page is at http://www.elmhurst.edu/~earls . Normally, I read my email fairly frequently, even when I'm not on campus. My office is Room 012 in the Schaible Science Center (SC 012). Please stop by and visit. Information about my office hours is posted on my office door. My office phone, (630)-617-3577, has 24-hour voice mail service. When leaving a voice mail message, it is best to make it more informative than a simple "call me." My fax number on campus is (630)-617-3735. At home my telephone number is (630)-920-9570. I don't mind being called at home when there is a real need to do so, though reaching me there may not always be quick or easy. When I am working on research at Fermilab or elsewhere, I may also have other appropriate telephone numbers posted on my office door.

## Overview and Objectives

To guide you in your efforts, I will often give you an overview, indicating important ideas and how they are interrelated, at the start of each unit of study (usually a chapter in the text). In any case, **the text provides detailed guidance on this front** at the end of each chapter.

# EVALUATION

## Grades

Your grade in this course will be based on your achievements in 5 areas: (1) assigned work; (2) quizzes; (3) the final exam; (4) laboratory work and reports; and (5) your "term paper." Work within each of the individual areas will be graded on a (somewhat arbitrary) point system. Designating the fraction of possible (assigned) points which you receive in area *i* by $f_i$, your final score in the course is given by the formula

$$S = 100\ (0.20\ f_1 + 0.30\ f_2 + 0.15\ f_3 + 0.20\ f_4 + 0.15\ f_5).$$

If you get a score of 65 or above, you are **assured** of at least a C in the course; 80 or above, a B; and 90 or above, an A (WOW!!). It is fairly easy to get a C with **good steady effort**, but you will need to really get your act together to earn an A or B. The following table summarizes the *meaning* of each letter grade in terms of level of academic achievement.

| Letter Grade | Achievement Level | PHY-414 Score |
|---|---|---|
| **A** | **Excellent (or Superior)** | 90% or above |
| **B** | **Above Average** | 80% or above |
| C | Average | 65% or above |
| D | Below Average (or Unsatisfactory But Passing) | below 65% |
| F | Failing | You don't want this. |

The formula tells you the **minimum** grade you will receive in the course. Several conditions could cause you to receive a **higher** grade. In assigning grades, I may lower the "break points" for some or all of the letter grades if I consider that this will more accurately reflect the achievements of the class as a whole. I may also exercise the option of adjusting an individual grade upward in recognition of truly outstanding achievement in some particular area of work (*e.g.*, an outstanding term paper) or of exceptional interest, enthusiasm, or participation in class discussion, *etc*. *You are responsible for keeping track of your scores in order to estimate how you are doing as the course progresses.*

## Assignments

As we progress through the semester, I will give you occasional assignments either from the text or of my own creation. You will usually have one week to complete them. Clarity of expression, correct use of terms and concepts from the chapter, logical reasoning, and thoughtful analysis are essential to formulating "correct" answers. Of course, in some cases no single response is, in itself, "the" right answer. Except in cases of illness, *etc.*, late assignments **will not** normally be accepted.

Hand-written assignments are to be turned in on 8-1/2" x 11" notebook paper, preferably with lines. Only **one side** is to be used. Odd sizes of paper or paper torn from spiral notebooks **will not** be accepted. Pages are to be numbered and clearly marked with the course number, your name, and the date. You should clearly show which questions are being answered. Answers should be complete, self-contained, and in numerical order. They must also be legible with proper grammar and syntax. In other words, you are expected to do a reasonably **professional** job of preparing your answers.

Each of you is required to attend **at least two campus intellectual events** during the term. To receive credit for your attendance, you must turn in a brief (one to three paragraphs) report discussing the role of either "**reliable evidence**" or "**scientific technology**" in the event content.

Each of you is also required to bring **at least two "science in the news" items** to class and present each of them to the class at the beginning of the class session.

When we start a new chapter, I will sometimes ask you to bring in one or two written questions. These questions may provide a basis for class discussion or help me recognize where you are unsure about material in the text. They also provide you with practice at formulating meaningful questions. They are to be legibly written on a 3" x 5" index card with the course number, your name, the chapter number, and the date in the upper left corner. I will discuss these "question assignments" further in class.

## Quizzes

Three (3) "full-length feature" quizzes are scheduled to play at this theatre during the semester. In addition, there may be short impromptu quizzes in class at any time. We will discuss the "ground rules" for these in class. Major scientific contributors, issues, ideas, concepts, and principles as well as their origins and applications will be emphasized on the quizzes and the final exam. Precision, clarity, and careful logical thinking will be stressed. In addition to the usual essay questions, there may also be multiple choice or matching questions. These will frequently be questions about definitions of important concepts, technical terms, units of measurement, historical figures, *etc.*

## Final Exam

A two-hour final exam will be given at the scheduled time. It will cover the entire term's work, with some extra emphasis on material covered after the last full-length quiz. The nature of the final, and the ground rules for it, will be essentially the same as for the scheduled quizzes.

## Laboratories

Laboratory scores will be based primarily on the written material turned in for each experiment, activity, or video tape. Clarity of thought and expression, completeness, and organization are very important in the lab "reports." Many lab activities are organized so that the "report" can be turned in at the end of the lab session. Others may require out-of-class analysis and/or writing and are due one week after the lab session. Normally, two points (out of 20) will be deducted if the report is turned in late. Reports that are more than one week late will not be accepted. **Active participation in the actual lab work and real exploratory effort in connection with it are likewise important in determining laboratory grades.**

## Term Paper

A short "term paper" – roughly 5 pages in length (typed, double spaced) – is required for this course. For this paper, you may pursue any one of three (3) paths.

1. You may prepare a paper that **critically examines** a particular example of pseudoscience.
2. As a second alternative, you may prepare a paper which systematically examines the origins of some of the scientific understanding necessary for a particular technological development.
3. As a third alternative, you may examine the broad impact of a science-based technology. To be more concrete, you focus on a specific technological development arising from the type of science discussed in this course. You decide whether the impact of this particular piece of technology on the world has been, on balance, positive ("good") or negative ("bad"). You then provide a coherent, logical argument in support of this judgement in your paper. Any technology that you can relate to physics is, in principle, acceptable.

**The choice is up to you,** but you will fare much better if your focus is fairly **narrow and well-defined**. I will, of course, be glad to help and will make suggestions as the term progresses.

**Note:** please don't waste your money on a plastic cover or binder for your paper – simply staple it in the upper left corner or, **better yet, submit it by email** as a WordPerfect (.wpd) or Microsoft Word (.doc) attachment. You are strongly urged to use a computer word processor to prepare your term paper and other written assignments. This facilitates correction and revision as well as providing you with broadly applicable experience using a helpful technology.

On or before the "proposal" due date indicated in the course schedule, you are to turn in one or two paragraphs explaining what you plan to do for the term paper. (For the third alternative, you must describe the chosen technological development and *tentatively* indicate whether you plan to take the "good" or "bad" view.) Include **at least four** (4) specific references you plan to use. Also note that I must receive a preliminary draft of the paper a reasonable time before the final version is due (submit by email or provide two (2) copies). **Each of these steps is essential to your learning from this work and to my accepting the final paper for full credit in the course.**

Please note the due date for the paper itself, which is somewhat before the end of the semester. It is important to have work on your paper "behind you" well before final exam week arrives. This is to be a "for real" paper – with sentences, paragraphs, **references to primary sources**, **citation of references**, page numbers, and all that jazz. (Imagine that I will take it to the English Department for a grade on presentation.) Clear expression, logical organization, and proper syntax and grammar are all essential. The College **Writing Center**, located inside the Learning Center on the main floor of the Frick Center, can help you in your effort to produce a high-quality paper. I will provide an example of a particularly simple, easy- to-use format for reference citation, but any standard format is acceptable.

Our textbook contains many excellent topic ideas. You should also look at chapters not explicitly covered as part of this course. The following can also provide you with ideas for topics (but only if you look at them):

"Quantum Leaps in the Wrong Direction: Where Real Science Ends and Pseudoscience Begins" by Charles W. Wynn and Arthur W. Wiggins; Joseph Henry Press from the National Academy Press, 2001.

"Voodoo Science: The Road from Foolishness to Fraud" by Robert L. Park; Oxford University Press, 2000.

"At the Fringes of Science" by Michael W. Friedlander; Westview Press, 1995.

"The Ascent of Man" by J. Bronowski; Little, Brown and Co.

"Cosmos" by Carl Sagan; Random House.

"A Scientist in the City" by James Trefil; Doubleday, 1994.

"Dreams of a Final Theory" by Steven Weinberg; Pantheon Books, 1992.

"The Dragons of Eden" by Carl Sagan; Random House.

"Galileo", a play by Bertold Brecht, Grove Press.

"Science, Technology, and Freedom" edited by W. H. Truitt and T. W. G. Solomons; Houghton Mifflin Co., 1974.

"Introduction to Concepts and Theories in Physical Science" by Gerald Holton and Stephen Brush; Addison-Wesley.

You might also look through *Scientific American, American Scientist, Skeptical Enquirer, The New Scientist, Science, Issues in Science and Technology, Technology Review,* or *Science News*. Daily newspapers, news magazines, general Web sites, *etc.* can also be good sources of **ideas**, though they are **not** in any sense authoritative scientific (or technical, or ethical, *etc.*) references.

# ACCOMMODATIONS

The College will make reasonable accommodations for persons with documented disabilities. If you believe that you have a disability that may have some impact on your work in this course, please contact the College *Disability Services Provider* Ms. Maureen Connolly at (630)-617-3753.

# ATTENDANCE

In accord with general College policy as stated in the Elmhurst College Bulletin (*a.k.a.* the College Catalog), regular class and lab **attendance is expected** and is a requirement for receiving a passing grade in this course. Class participation and lab work are essential parts of the course and contribute to your grade. If you must miss a course meeting, you must also take the responsibility for completing any assigned work for that day. Make-up tests will be given only in very special cases. (Anyone who dies during the course will be given one – and only one – make-up test.) Students who miss more than an occasional class invariably find it **very difficult** to earn a satisfactory grade.

# WARNING

**Academic Honesty is Essential!** Academic honesty is a requirement for receiving a passing grade in this course. In your term paper, tests, problem solutions, *etc.*, **do not** represent the work of someone else as your own. Any form of cheating is a serious offense, and the **normal penalty** is a **failing grade in the course for all involved**. This includes any student(s) who actually did the work! More severe action can and will be taken in extreme cases. In any case your reputation will be substantially damaged. I am obligated to report any instances of academic dishonesty to both the Vice President for Academic Affairs and the Dean of Students.

You are expected to become familiar with the general College policy on Academic Integrity as stated in the E-Book. Copies may be obtained from the Office of the Dean of Students in the Frick Center. The content of the E-Book applies to this course. I will also provide you with a copy of the Natural Sciences Division policy statement on this subject. If you have questions about this matter, please discuss them with me.

# COURSE EVALUATION

Near the end of the semester, you will be given the opportunity to provide a confidential evaluation of various aspects of this course, including my performance as an instructor. If you have *suggestions for improvements*, they will be of even more use if they are made earlier than the formal evaluation. So please talk to me about them, send me an email note, or if you wish anonymity, slip a note under my office door or send it to me *via* campus mail (Campus Box #3). The course you save could be your own!

# DISCLAIMER

The course syllabus and schedule are not a contract between instructor and student but rather a general guide to course expectations and procedures. While the provisions are as accurate and complete as possible, the instructor reserves the right to change any provision if appropriate. Students will be duly advised of such changes in class. It is the responsibility of each student to know what changes, if any, have been made and to successfully complete the requirements of the course.