GENERAL PHYSICS

PHY103 — Summer 1994

PHY103 is an introduction, at the non-calculus level, to Mechanics, Heat, and Sound, with applications to a number of different fields. The study of Electricity and Magnetism, Light and Optics, and Modern Physics is covered in PHY104. The prerequisite for this class is high school math including some trigonometry.

Format	Four Lectures	MTWR	8:55am – 9:45am	1300 Sterling
	Four Discussions	MTWR	10:20am – 11:10am	1407 Sterling
	One Lab	MW	1:10pm – 3:05pm	4313 Sterling or
		TR	1:10pm – 3:05pm	4313 Sterling

Instructor Theo Koupelis, office no. TBA

Text *College Physics,* 3rd ed., Serway and Faughn (Saunders/HBJ 1991)

Office Hours MTWR 11:30am – 1pm
or by appointment

Goals

1) To learn how to order the complex appearances detected by our senses.
2) To understand how science is structured and develops, through the use of contemporary problems in physics.
3) To study the historical development of the ideas used in physics, ideas that changed the human race forever.
4) To learn how to distinguish between science and pseudo-science.
5) To illustrate the value and cost of the scientific enterprise and to promote rational examination of the appropriate use of public funds.

Library Journals of particular relevance include *Americal Journal of Physics, Physics Teacher, Physics Today, Science News,* and *Scientific American. Nature* and *Science,* also available, are highly technical journals but include sections covering news and commentary on current matters.

Grade

Lab Reports and Lab Quizzes	20%	
Homework	5%	
Four 20min Quizzes	5%	
Four Hour Exams	70%	6/23, 7/14, 7/26, 8/4

Exams

There will be four one hour exams as listed above. All needed constants and formulas will be provided on the cover sheet of the exam. *There will be no early, late, or makeup exams.* If you miss an exam, the average of your other exams will be substituted for the missing score *provided* that you have a written excuse from a physician, Dean, or academic advisor, or a substantiated unforseen occurrence. The hour exams are normalized with the better scores counting most: 25%, 20%, 15%, and 10%, in order of score.

Homework

The homework is due in class on the due date shown in the syllabus. Solutions to the homework will be in the reserve shelf in the Physics Library. It is essential that you work on the assigned homework as soon as possible. The pace is twice that during the regular semester, so start the homework early!

Labs

You must complete *all labs* in order to pass the course. If you miss a lab you should check with your instructor immediately about making it up. The final grade for lab reports is the average of the individual grades for each lab with a missed lab counting as zero (0). You must have a bound quadrille notebook for your laboratory work; this notebook will remain in the laboratory. The lab schedule shown in the syllabus is for the MW section. Those in the TR section will do the same labs on Tuesday and Thursday as shown for Monday and Wednesday. There will be a 10min quiz in each lab about the preceding lab, starting from the second lab. You may use your notebook but **not** the manual.

Rules

- Late homework will **not** be accepted or marked.
- Constant attendance is assumed.
- Announcements may not be repeated, so that faithful attendees will not be subjected to repetitious definition of terms and announcements.
- Examinations will be based on both lectures and reading assignments. There will be **no** "curving" of grades. Minimum passing grade is 52%. All grades, from D to A are evenly spaced; A: 100–92; AB: 92–84; B: 84–76; BC: 76–68; C: 68–60; D: 60–52; and F: < 52.

General Advice

The lectures will be more useful if you are current in the reading assignments. Your text, like most recent texts, includes everything. We may omit or briefly cover some topics (not because they are without merit) to avoid spreading ourselves too thin. If the class so desires we may cover some topics in more detail. Reading assignments will be given for each lecture.

What is expected from you? Study the figures and illustrations of scientific principles and results. Are they based on experiments or conjecture? Is there a term you cannot define? Check the index and appendices. If you skip class and are behind in the reading you may not be able to follow the lectures with so many new terms you don't recognize. If you are current and I am running off without explaining a term, please challenge me to explain myself.

As you read ask yourself "How is this known?" Nature is the true authority, **not** the text! Is the fact deduced from experiments (e.g., conservation of energy and momentum), from observations (e.g., Newton's law of gravity), or merely definition (e.g., matter)? Laws, Theories, Models, Hypotheses, and Scenarios are all generalizations from nature of descending certainty which may be inconsistent with later discoveries. I hope to tell you how nature "works" and how we come to know it.

Study aids in the text and the summary provided at the end of each chapter should be invaluable in reviewing for examinations. The set of references given at the end of each chapter provide access to other treatments of the subject which may help you understand the concepts better.

If this is your first science class, or if you are uncertain on how to read a science text, read carefully the handout "On Mathematics and how to Read a Science Textbook." If you still have questions, come and see me.

It is obvious that each student has different ideas as to what constitutes a good class and a good instructor. It should also be obvious that I will not know if there is a problem in the class unless you tell me so. If you have any suggestions for making the class better, or if you have a problem with the way I present things, use the "evaluation" form handed out at any time during the term. Do not wait until it is too late to "fix" whatever the problem may be. I cannot read what you are thinking. You are as much responsible for what you are learning as I am. Be active in class, learn how to defend your opinions, learn how to accept someone else's if they are right, express your concerns, make constructive suggestions, learn, and learn how to learn. Do not worry about grades, yours or anybody else's. You should try and do the best you can compared to the standards I set for this class. The degree to which you meet them will correspond to your grade.

PHY103 – Tentative Schedule (6/13/94)

Week	Date		Chapter	Lab Topic	Homework Problems
1	M	June 13	1–Introduction	No Lab	—
	T	14	2–One-D Motion		—
	W	15		M1–Density of a Solid	Ch.1: 5,20,29,34,40,44,45
	R	16	3–Vectors		Ch.2: 4,15,18,23,31,34,43,45,53,54
2	M	20	4–Laws of Motion	M4–Free Fall	—
	T	21			Ch.3: 3,14,15,19,24,31,33,38,48
	W	22		M2–Equilibrium	—
	Exam #1: Chapters 1–4, 8:55am, Thursday, June 23				
	R	23	5–Work and Energy		Ch.4: 4,6,20,34,35,51,56,59,76,81
3	M	June 27		M10–Power and Friction	—
	T	28			—
	W	29	6–Momentum	No Lab	Ch.5: 8,16,19,28,31,44,52,69,73,77
	R	30			—
4	M	July 4	No Class	No Lab	—
	T	5	7–Circular Motion		—
	W	6		M5–Momentum Conservation	Ch.6: 10,14,18,26,32,34,46,49,55,63
	R	7	8–Rotational Dynamics		
5	M	11		M6–Centripetal Force	Ch.7: 11,15,26,32,33,43,46,74,75
	T	12	9–Solids and Fluids		
	W	13		M3–Rigid Body Equilibrium	Ch.8: 7,11,16,20,33,36,37,48,51,58,65
	Exam #2: Chapters 5–8, 8:55am, Thursday, July 14				
	R	14	10–Fluid Motion		—
6	M	18		M9–Ang. Accel. of Flywheel	Ch.9: 1,14,16,21,23,28,39,43,70
	T	19	11–Thermal Physics		Ch.10: 3,10,13,23,30,50
	W	20	12–Heat	M11–Young's Modulus	—
	R	21			Ch.11: 5,14,18,23,40,49,55,77,78
7	M	25	13–Thermodynamics	H2–Gas Thermometer	—
	Exam #3: Chapters 9–12, 8:55am, Tuesday, July 26				
	T	26			Ch.12: 5,12,22,32,41,53,60,65
	W	27		H3–Heat of Fusion or	
	R	28	14–Vibrations/Waves	H4–Heat of Vaporization	Ch.13: 5,14,18,25,41,42,46,48,51
8	M	Aug. 1		M7–Pendulum	—
	T	2	15–Sound		Ch.14: 2,12,19,28,33,37,56,70,74
	W	3		S1–Strings	—
	R	4			Ch.15: 2,14,17,28,31,40,51,73,77
	Exam #4: Chapters 13–15, 10:20am, Thursday, August 4				

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Evaluation Form

Optional: • Check One: Required ________ Elective ________

• Intended Major: ____________________________

1) What is your opinion of your instructor's teaching effectiveness in this course up to date? Comment on the strength and weaknesses of your instructor (e.g., organization of notes, mechanics of teaching, generating interest in the subject, answering students' questions, fairness of grading system, content of exams, etc.).

2) Comment on the strengths and weaknesses of the structure and content of this course (e.g., appropriate prerequisites, material challenging and worth learning, workload, suitable homework assignments, suitable textbook, organization and helpfulness of labs, etc.).

3) What changes in the course and in the teacher's methods and manner of instruction would you suggest?

ON MATHEMATICS AND HOW TO READ A SCIENCE TEXTBOOK

based on *Understanding the Universe*, by Philip Flower, 1990

Scientific subjects such as environmental problems, the energy crisis, AIDS, medicine, engineering, space exploration, etc., have become front page news. What we do about the problems existing on our planet and the way we react to the new developments affects, like it or not, not only our personal lives but also the lives of the rest of humanity. There are many magazines and books that explain in detail the recent advances in science, but a nonspecialist may find them difficult to understand because of the specialized and technical language they use, even though this same language helps scientists communicate efficiently.

Popularizations of the recent advances in science are contained in magazines such as *Science News*, *Scientific American*, *Astronomy*, *Sky & Telescope*, etc., and in some newspapers such as *The New York Times*. By simply reporting the results and what they mean, these popularizations avoid two main difficulties that a nonspecialist may confront in reading the more technical literature, i.e., the lengthy details of the calculations and/or experiments, and all the dreadful mathematics. While the first omission is welcome (sometimes even to a scientist working on another subject), the intentional omission of even the most basic mathematical calculations is not necessarily a blessing.

First of all, mathematics is the language of science and as such it has its own vocabulary, symbols, and syntax. So why is it any harder to learn than, say, Japanese or Spanish? Is it because the "math anxiety" most people have is not relieved by working out problems with paper and pencil (making mistakes at the beginning like everybody else)? You cannot gain confidence in your mathematical abilities unless you try to work out the simple mathematical examples you come across as you read. After all, the purpose of reading a book is not to become a mathematician but to understand the problem under consideration; it is not to accumulate information that you may or may not fully understand but to increase your understanding of the subject.

Secondly, why is it any easier to describe a phenomenon with words instead of using an equation? And what is the purpose of an equation anyway? Let us consider the following very simple example. You drive your car at 60 miles an hour for one hour. The distance you travel is, of course, 60 miles. If you travel twice as fast for an hour then you will cover a distance of 120 miles. This is indeed very easy and there is no need for anything more except words. But what if you travel at 60 miles an hour for 20 minutes? Or, at 72 miles an hour for 7.5 minutes? How do you find the answer to these questions if you don't know the *relationship* between the parameters involved? A relationship which is *described* by an equation. What's wrong in saying that $d = vt$? What does this equation *say*? Doesn't it say that: the distance (d) traveled is equal ($=$) to the velocity (v) of the car multiplied by the travel time (t)? So the equation is actually the *same* thing as using words to describe the phenomenon. But it goes beyond that since it includes *every* possible combination of speeds and time durations, something we cannot do by omitting the equation. Since an hour has 60 minutes, then 20 minutes is a third ($\frac{1}{3}$) of an hour, and 7.5 minutes is an eighth ($\frac{1}{8}$) of an hour. Thus, the distances traveled in the above examples are $60 \times \frac{1}{3} = 20$ miles, and $72 \times \frac{1}{8} = 9$ miles, respectively.

Thirdly, by knowing how to work out very simple problems we can learn so many more things about what we are reading. Let us consider the following case. You are reading an article about the Sun, and somewhere in the article the author mentions that the Earth receives 1370 units of energy (Joules) for every square meter of area (m^2) for every second. (By the way, an energy of one Joule is what is required to raise the temperature of one gram of tap water by one fourth of a degree.) Does this information tell you anything? As it is, probably not. Now, the Earth has a radius (R) of 6380 kilometers, and thus the surface area (A) where this energy is falling on is $A = \pi R^2$, where π is a constant number approximately equal to $\pi \simeq 3.14$. Thus, $A \simeq 3.14R^2 \simeq 1.3 \times 10^{14}\text{m}^2$. Therefore, the Earth receives $1370 \times 1.3 \times 10^{14} = 1.75 \times 10^{17}$ Joules every second, or 5.5×10^{24} Joules in a year. Does all this mean anything now? You may say it is getting worse, and you don't see the point. Well, let us make one more step. What if I told you that when you get your electricity bill and see the total amount, it really says that you pay about 7.5 cents for every 3.6 million Joules? That means that if we could collect for a year all the energy the Sun sends us for free, this energy will be worth $5.5 \times 10^{24}/3.6 \times 10^6 = 1.5 \times 10^{18}$ U.S. dollars, that is more than one million trillion dollars a year! Does *that* mean anything to you now? Of course we cannot collect all the energy and the efficiency with which we can use it is not 100%. But let us use some very conservative estimates. If we cover with solar cells a square area in space with a side of 64 kilometeres (i.e., 40 miles) and are able to use only 1 out of every 100 Joules we collect (i.e., a 1% efficiency), then the amount of energy we will use will still be worth more than one trillion dollars every year.

With all the problems facing our planet and the fact that we can make a difference with our actions, it is *imperative* to be able to see beyond the smoke-screens, disect the fake reports, acknowledge the facts, face the choices and solutions, and do something about them. Science seems to play an important role in all of this, and for us to be able to play a constructive part in the choice making process we must speak its language, at least in the most basic level.

How does one go about reading a science textbook? Nobody expects you to understand everything in the book by reading it once. You will probably find many descriptions of phenomena that seem incomprehensible. As a matter of fact, there are some descriptions that the scientists themselves do not fully comprehend. Our understanding of what happens in the cosmos evolves, and some of our ideas may be disproven in the future. Just as scientists learn by trial and error, experiments and theoretical models, you improve comprehension by developing your reading skills.

There are three levels of reading. The *elementary*, *inspectional*, and *analytical* reading levels. The first level requires only the skill of being able to recognize the words and understand their meanings when we read a paragraph. It is indeed very sad that in our age the number of people who cannot read is too large to be acceptable by any standards; and it becomes even more sad when one thinks of the reasons and/or excuses for the continuation of such a situation.

What you, the reader, should care about at the level of *inspectional reading* is familiarizing yourself with the book without worrying about the details and without stopping at difficult places. Discover what the book is all about and gain an overall view of the topics covered and their order. The most important thing at this level is to concentrate on the big points being made. How do you do all this? First, look at the table of contents to see what topics are covered and try to determine if there is a reason for their particular order. Second, find out if the book includes some appendices and a glossary (a dictionary defining some of the terms often used in the jargon of each discipline) which you may find useful as you start reading the chapters. Some books also include at the end of (almost) each chapter an essay where a specific idea, loosely related to the main subject of the chapter, is expanded upon (e.g., on the chapter about Earth you may find an essay on the Ice Ages, and on the chapter about Asteroids you may find an essay on Extinctions of Dinosaurs). Read the introduction and the summary of each chapter and get an idea of what the text is all about and what kind of reading is expected of you. And again, the most important thing: concentrate on the overall picture and do not worry about the details.

Analytical reading is active, and the more active your reading is the more you will benefit. A science textbook/magazine/article presents you with information about things you are probably not very familiar with, and it does not tell you what to do with this information. When you read a science textbook if you find yourself asking the questions: *What is this book about? What is being said in detail? Is what is being said true? So what?* then you are on the third level of reading. Your purpose here is to understand, to ask questions, to check the information and conclusions presented to you and to convince yourself that they make sense. Do not accept the things you read as facts, do not assume that the author presents the absolute truth unless you are convinced by the arguments. Discover the important points of each paragraph and how they are developed, find if they are significant and why and, again, make sure you are convinced by the information and the reasoning presented to you. If you are confused about something, or if you think you need more information, ask your instructor.

The best way to work at the *analytical reading* level is with pencil in hand to write in and mark the text and express what you are reading in your own words. Find what connects the ideas presented in the different paragraphs and how they are in turn connected to the main point of the chapter, and write this down in your own words. As your various types of markings you can use: 1) underlining the main points of (but not all) the paragraph; using vertical lines or symbols (e.g., an asterisk *) in the margin to emphasize underlined statements or long but important passages; 2) using numbers in the margin to mark a sequence of arguments or observations made to support a theory; 3) making cross references when you notice that the same point is made again later in the book (usually with more details) and thus finding connections across the whole book. And again, the most important thing for you is to write important points in your own words. When you try to do that, you will find which ideas you do not understand. You can mark them and come back to them later, and at the end you will be able to review the important aspects of a section by looking at your own notes instead of having to read the section all over again.

You are not expected to become an expert of a subject by reading a book on it and following the suggestions presented here. Hopefully though you will be able to understand the subject, appreciate the problems that still exist, and with your knowledge be able to play, in your own way, a constructive role in the efforts for their solutions. As mentioned before, like it or not, our actions or inactions on some problems affect not only us but everybody else on the planet. In that sense it is our *duty* to make sure we understand the problems and take a part in the efforts to solve them.