Foundations of Physics III

Fall 2006; 8:00 A.M. odd | Physics 211 | PEngel 173

Instructor:

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Office Hour: 3 P.M. Day 5   Informal Office Hours: 7:30 A.M. – 5:30 P.M.

Texts:

- *Fundamentals of Physics*
  by David Halliday, Robert Resnick & Jearl Walker (Wiley, 2005 7th edition)
  Chapters: 14–20, 33–36
- *Six Ideas That Shaped Physics: Unit T — Some Processes are Irreversible*
  by Thomas A Moore (McGraw-Hill, 2003 2nd edition)
  Chapters: T1–T9
- http://www.physics.csbsju.edu/211/

Grading:

Your grade will be determined by averaging six scores: total homework score, three exam scores, and the final exam score (which is double-counted). Assigned homework is due at the beginning of the next class period. Late homework is generally not accepted. You may use a single-sided $8\frac{1}{2}$" $\times$ 11" "formula sheet" to assist you on the exams. The formula sheet should be limited to formulas and definitions—no worked examples. Exam dates are: September 26 (Tuesday), October 31 (Tuesday), and December 11 (Monday). If informed in advance, I may be able to accommodate exam conflicts. The final exam will be comprehensive and have a structure similar to the other exams, but proportionally longer. The final exam has been scheduled for 11 A.M. Tuesday, December 19.

Lab:

You should probably also be registered for PHYS 332: Intermediate Lab, although that is an entirely separate course, with no direct connection to this course.

Questions:

There is no such thing as a dumb question. Questions during lecture do not "interrupt" the lecture, rather they indicate your interests or misunderstandings. I'd much rather clear up a misunderstanding or discuss a topic of interest than continue a dull lecture.

Remember: you are almost never alone in your interests, your misunderstandings, or your problems. Please help your classmates by asking any question vaguely related to physics. If you don't want to ask your question during class, that's fine too: I can be found almost any time in my office (PEngel 111) or the nearby labs. Drop in any time!

Topics:

This course covers the two remaining sections of classical physics: waves and thermodynamics. Both topics are closely connected to quantum mechanics and hence "modern physics". Quantum mechanics involves the discovery that the objects we called particles in 191 act (in part) like waves and historically thermodynamics provided the first evidence for "quantum" behavior. Both of these topics are also closely connected to practical devices: telescopes, microscopes, refrigerators and engines of all sorts.

As always a big part of physics is mathematics. In 191 differential equations ($F = m\frac{d^2x}{dt^2}$) played the central role. In 200 integral equations (like Gauss's law and Ampere's law) were central. In this course, you'll find complex numbers provide the simplest way to describe waves and vector spaces (which you'll be learning about in Linear Algebra) will be applied to find Fourier series. Additionally we'll use some simple combinatorics to describe the statistical mechanics which underlies thermodynamics.

You will have noticed that our usual textbook (HRW) is being augmented this semester with Unit T from *Six Ideas that Shaped Physics* (Moore). Unit T is the sixth idea in Moore's sequence, and so it relies a bit on material you will cover next semester: quantum mechanics. As a result you'll have to take on faith a main result of quantum mechanics: that, for example, a particle's possible energy — instead of being continuous — must fall in a countable set of possible values ('states'). While we could derive many of the needed results assuming continuous energy possibilities (i.e., in the classical approximation), the discrete list of states we'll be using is both more accurate and easier (once you get used to these odd quantum ideas). The singularly important result we gain from using Moore is the Boltzmann Factor:

$$\text{Proability} \propto e^{-E/k_BT}$$

This result is needed on page one of most any branch of modern physics.

Using two books has the disadvantage of mixing two notations and writing styles. I think you'll enjoy Moore's writing style; instead reading like an encyclopedia, he clearly is enthusiastic about how these big ideas shaped physics and the world. Usually living with two notations amounts to learning to "equivalence" different letters that are used to represent the same quantity. For example, after a quick check of the books on my shelf I found the following notations used for torque: τ, N, M (from moment), Q, and T. However HRW and Moore have a more serious disagreement: the same letter is used to represent opposite quantities! HRW write the first law of thermodynamics as:

$$\Delta E_{\text{int}} = Q - W \tag{18-26}$$

whereas Moore writes this same law as

$$\Delta U = Q + W \tag{T3.1}$$

that is Moore and HRW define the work W oppositely. We will follow HRW in class (and in homework and exams!), but I nevertheless applaud Moore for trying to replace the historically usual definition of *work* with one more congruent with physics.