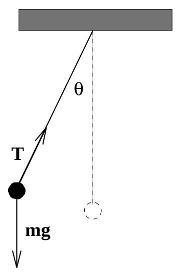

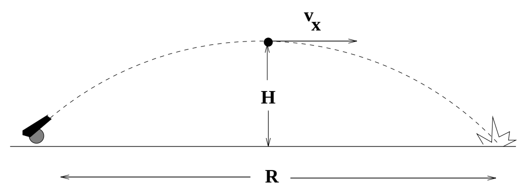

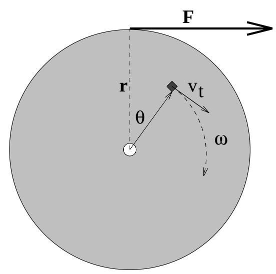

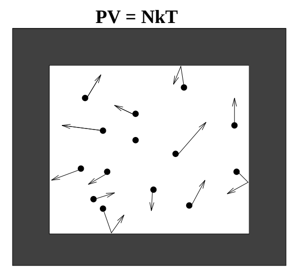

Syllabus for
Physics 41
Introductory Physics for Majors

Fall Semester, 2008

Robert G. Brown, Instructor
Duke University Physics Department

Contents

1 Physics 41, Introductory Physics for Majors

1.1 Contact Information

Course Instructor: Robert G. Brown Room 260
Email address: rgb@phy.duke.edu Phone: 280-8443
Course Web page address: http://www.phy.duke.edu/~rgb/Class/phy41.php

Text: Tipler and Mosca, *Physics for Scientists and Engineers*, 6th Edition.
Supplemental Text: http://www.phy.duke.edu/~rgb/Class/intro_physics_1.php

TA/Lab Instructors

Recitation: TBA
Lab: Mark Steadman mls59@phy.duke.edu
Recitation: Ashley Jones adj11@duke.edu

1.2 Course Description

In this course we will cover the following basic topics:

- Elementary Mechanics: Motion in 1-3 dimensions. Newton's Laws. Work and Energy. Systems of Particles and Conservation Laws. Rotation. Static Equilibrium for Rigid Bodies. Gravity. Mechanics of Solids and Fluids. (Tipler: Part 1) Math skills required: Trigonometry, Algebra, Calculus. 6-7 weeks.
- Oscillations and Waves: Oscillating systems. Waves. Sound. (Tipler: Part 2) Math skills required: Algebra, Calculus, a bit of Differential Equations (which we will learn in place). 2-3 weeks.
- Thermodynamics: Temperature. The Laws of Thermodynamics. (Tipler: Part 3) Math skills required. Algebra, Calculus. 2-3 weeks.

1.3 Grading Scheme

The structure and organization of the course will be (approximately!):

10-15% of grade Lab (including "Project")

20% of grade Weekly Homework

20% of grade Weekly Quizzes

45-50% of grade Hour Exams (3) and Final

Note Well! There will be lots of homework problems, and they will be quite challenging. Homework is an *essential* part of learning physics and must not be neglected. I expect all students to do the assigned problems and keep up with the reading. On the other hand, I have a *big* chunk of credit out for homework!

Note Well! The lab *also* makes a significant contribution. I've had students drop a full letter grade on numerous occasions because they did not take lab seriously. The lab in this course will be managed in a new way that more or less eliminates the "cookbook complaint" – labs that are boring because all you have to do is follow directions. You will have to *invent your own way* of achieving the goals set forth for you in lab, with only guidance from the lab TA(s), not step-by-step instructions. This *should* be really fun and challenging, but it means that you will have to really think and use your creativity and perhaps do some research to figure out the best way to e.g. measure g or observe $PV = NkT$ in a gas.

In the scheme above the final exam can replace any *one* hour exam grade, provided that it is higher. This allows students to make up for their worst single hour exam performance with their final, so one bad day won't hurt your grade. If you get below a 50 (and the curve is otherwise normal) and have not religiously handed in your homework, you fail (F). If you get less than a 60 and have not religiously handed in your homework, you get an D. If you get 60 or more you get a C- or better and "pass". If you have religiously done your homework, but have somehow managed to end up less than a 60 or (worse) 50, this will be taken into account and adjustments *may* be made at my discretion. If you have not religiously done and handed in your homework on time, *don't bother me about your grade.*

I'm often asked if I grade on a curve. Yes and no. I grade on a 25-year curve with a few absolute points in it – 50 and 60 as breakpoints for F and D, for example. This is often to your advantage. If you get a 90 or higher for your cumulative final average in the course, for example, I will give you an A of some sort even if the class mean is 95. If the class mean turns out to be 70, on the other hand, I'll assume that I have failed you and grade on a B- curve, but that hasn't happened for a very long time.

If someone is very concerned about their grade, they should see me early and often; extra credit can be obtained a variety of ways (especially by doing a project) to help avoid a bad grade or to augment a good one.

1.4 The Class Rules

- You **may** collaborate with your classmates in any permutation on the **homework**. In fact, I encourage you to work in groups, as you will probably all learn more that way. However, you must **each** write up *all* the solutions even if they are all the same within a group. Writing them up provides learning reinforcement.

- You may **not** get worked out solutions from more advanced students, former students, a Tipler solution manual (if you can find it), online, or anyplace else. It obviously removes the whole point of the homework in the first place.

- You **may** ask more advanced students, former students, other faculty, personal friends, or your household pets for help or tutoring on particular problems, as long as no worked–out solutions to the assigned problems are present. Again, if you work in groups I encourage you to take turns teaching each other the solutions to the problems you encounter, as teaching is an excellent way to learn.

- You may use the library and all available non–human resources to help solve the homework problems. I don't even care if you find the solution somewhere and **copy it verbatim** provided that you understand it afterwards (which is the goal), **cite your source**, and provided that you do **not** use the solution manual for **Tipler** problems (which exists, floating around somewhere), see second item above. I would prefer that you do not routinely look for solutions rather than work them out yourself; save this approach for the toughest problems. Remember, you can't take these resources into an exam with you; you will need to learn to solve the problems on your own.

- Homework will be handed in on the **Friday** following the **Wednesday** recitation. It must be in the class box before 5 pm, unless you have made *prior* arrangements with the TAs (not me). As you will learn, possibly the hard way, recitation is NOT to be used to for doing *all* of your homework unless you enjoy pain and failure. The quiz following recitation will typically be drawn heavily from your homework, so students who complete and understand it in time will generally do well on the quiz and end up a full letter grade better than an equally "smart" student who doesn't take the time to do most of the homework before coming to recitation.

- Quizzes and Exams: All quiz and exam problems are to be worked out alone, with no aids other than an ordinary calculator or arithmetic device. Calculators may not contain any physics formulae in memory or firmware. Looking at or copying other students' work is not permitted, and (as an honor code violation) may be severely penalized. I assume that all my students are honorable persons and will play the game honestly. If you indeed do choose to major in physics, then the usual homily of "cheating yourself" when you cheat in class is never truer. You *will* have to learn all the material we cover to succeed – the only question is whether you wish to be miserable (and dishonorable) in you academic pursuit before you end up having to do the work required anyway.

1.5 Class Details

I will usually be available in my office for questions anytime after 9 to 10 am in the morning most days. You should feel free to see me on a drop-in basis, although sending me an email to make sure I'll be around is better. If you have any trouble finding me or need to see me at any other time, it is best to make appointments to see me via e-mail. I have a few other duties and responsibilities and like to be *able* to leave by 3 pm to pick up my kids from their school, although I won't do so every day.

Your TAs are also generally available for help in the coursework. I'd suggest using their email addresses given above to schedule appointments, although they may also set up a regular office hour.

Recitation will be used to go over and work the most difficult homework problems, and additional problems I may give you in recitation, in small groups. This is intended to be a time when you teach each other, and learn thereby. Hans and I will move from group to group and provide tutorial support. Students may be asked to present problems at the board for the entire class or present problems on paper for another group at any time. Computers may be used to simulate some of the mechanical systems that we study. A graded short quiz will generally terminate recitation.

I welcome feedback and suggestions at any time during the year. I would prefer to hear constructive suggestions **early** so that I have time to implement them this semester.

There is a set of notes (really an online supplementary textbook) being provided on the web to my students as a convenience. Direct your browser to:

http://www.phy.duke.edu/~rgb/Class/intro_physics_1.php

and click on on the Intro Physics I link.

2 Mailing List

This class is set up with its own mailman-based mailing list at the address

`phy41@phy.duke.edu.`

I would like this list to be used FIRST with questions on homework problems, exam problems, or things you didn't understand from lecture or recitation or lab. This is because you all will learn the most from teaching each other, and the list enables discussions to occur that are very instructive to all that participate. List membership is required, not optional, and the instructors including myself will use it exclusively for communications ”to the entire class”, some of which may not otherwise make it into lecture announcements.

Your mail to the list will go to the entire class, including me, Dr. Mary Creason (your lab professor) and your TAs. Ideally, one of your classmates will answer your questions, but if not the instructors are there as backup and your questions *should* get answered. The list archives all traffic so you can go back and look at answers later to study.

Use “latex”-style encoding of greek letters and equations to discuss mathematical relations on list. Some examples:

```
\vec{F} = m\vec{a}
\x(t) = \frac{1|{2} a_0 t^2 + v_0 t + x_0
v_f = \sqrt{2 g H}
```

are expressions we’ll encounter in the first week or so. They render in latex as:

$$\vec{F} = m\vec{a}$$

$$x(t) = \frac{1}{2}a_0 t^2 + v_0 t + x_0$$

$$v_f = \sqrt{2gH}$$

With a bit of practice (especially practice involving the actual use of latex to write up algebraic text) you’ll be able to read algebra in this sort of ascii encoding as easily as you read the real thing.

2.1 List Etiquette

Please do not use the list for truly frivolous purposes, although I’m pretty tolerant about social usage as long as it is directed at the class itself as a social group (e.g. announcing pizza/study parties). All physics related, philosophy related, class related traffic is openly encouraged.

2.2 Mailman List Control

Mailman lists give you a lot of options you can control regarding how you receive the mail and more. Although membership is mandatory (please do not unsubscribe) you can e.g. select digest mode if traffic is too distracting. This list also maintains archives of all traffic, and it is a good idea to review it from time to time if some discussion of difficult problems has occurred. Option control and the archives can be found at:

http://lists.phy.duke.edu/mailman/listinfo/phy41

3 Physics 41, Homework 2008

3.1 About Homework Assignments

All homework is from Tipler and Mosca's *Physics for Scientists and Engineers*, sixth edition. To do well in this course, plan to work on homework for a minimum of **3-5 hours a week** in *advance* of the recitation period where homework will be reviewed and completed as necessary. There is time to resolve and understand 3-5 homework problems during recitation. There is *not* enough time to do an entire assignment and prepare for a challenging quiz on the same material (quite possibly drawn from a homework problem).

Homework is to be turned in for grading before 5 pm on the Friday following the recitation where it is reviewed. The actual dates for each assignment are given below. Homework will be graded according to the following scheme:

- (Usually) 5 points for having a complete assignment, where every problem is at least attempted on paper. Points will be subtracted if problems are missing (completely untried) or where the attempt isn't serious. At the very least hand in a summary of things you tried to solve any problem you cannot get. Remember, I or the TA will help you solve *any* problem you ask about in or after recitation, so there really isn't any good excuse for not solving them all.
- 5 points will be assigned on the basis of a detailed grading of one problem. Since *all* students should be able to get *all* the problems right by the end of recitation or at worst by Friday following, a significant part of this grade will be awarded on the basis of "style" – how *well* you work a problem, how effectively it is laid out, whether there is a good drawing accompanying, whether you worked neatly and spread out instead of in tiny print and all jammed together. You can easily lose a point or two to this, so present your solutions properly!

If you have difficulty completing any assignment on time, you should contact the recitation TA to ask for forbearance. I leave decisions to accept or not accept late homework (or to accept it with a penalty of some sort) up to them entirely, as they are the ones inconvenienced. Usually they are tolerant of a few screwups per student per semester, but if you make a habit of being late, count on being penalized eventually.

3.2 List of Assignments for Fall, 2008 (under construction)

Note Well!: The problems in the **first** table are corrected for the sixth edition. The ones below that are from the old fifth edition and I'm leaving them there for my own use for the time being. It looks like the 6th has very few problems in common with the 5th, and many good ones have gone away, so I'll likely have to choose quite new problems for this semester. This will take a bit longer than just moving them would, sorry.

Week	Subject	Chapter: Assignment	Reciation Date Due
1	Kinematics	1: 76 2: 12,13,14,82,91,93,96,97 (note typo: 97 refers to problem 96, not 100),115,117	9/3/08
2	Kinematics	3: 56,67,69,75,79,84,93,97,98,100,118	9/10/08
3	Newton's Laws	4: 50,53,62,66,79,81,82,84,92,98	9/17/08
4	Newton's Laws	5: 34,59,80,85,87,94,109,118,134,138	9/24/08
5	Energy	6: 29,35,47,62,73	10/1/08
		7: 29,46,58,65,94,101	10/1/08
-	Fall Break	Work on Momentum and Rotation	10/11/08-10/19/08
6	Linear Momentum	8: 32,40,59,61,64,66,67,88,105,116,117	10/24/08
7	Rotation	9: 47,53,62,77,80,96,100,112,126,128	10/24/08
8	Angular Momentum	10: 40,50,52,53,61,79	10/31/08
	Static Equilibrium	12: 26,33,45,65,75,76	10/31/08
9	Gravity	11: 29,59,68,78,79,92,104,106	11/7/08
	Fluids	13: 40,50,65,69	11/7/08
10	Oscillations	14:71,74,92,97,105,106	11/14/08
	Waves	15: 44,63,64,83,86,104	11/14/08
11	Waves (cont)	16:	11/21/08
	Thermodynamics	17:	11/21/08
-	Thanksgiving Break	Work on Thermodynamics	11/26/08-11/30/08
12	Thermodynamics (cont)	18:	12/5/08
12	Thermodynamics (cont)	19:	12/5/08

3.3 How to Do Your Homework Effectively

By now in your academic career it should be very apparent just where homework exists in the grand scheme of (learning) things. Ideally, you attend a class where a warm and attentive professor clearly explains some abstruse concept and a whole raft of facts (too many, in fact, to fit in short term/working memory and with too little time to move most of them through into long term/working memory). You've forgotten many if not most of the facts, but if you were paying attention and really cared about learning the material you remember a handful of the most important ones, the ones that made your brief understanding of the material hang (for that moment) together.

Your professor gave you an assignment in support of the lecture. It is time to do it. *How* should you do it to both learn all that stuff you missed in lecture and to re-attain the moment of clarity that you then experienced, until eventually it becomes a permanent characteristic of your awareness and you *know* and *fully understand* it all on your own?

There are two general steps that need to be *iterated* to finish learning anything at all. They are a lot of work. In fact, they are far *more* work than attending lecture, and are *more important* than attending lecture. You can learn the material with these steps without *ever* attending lecture, as long as you have access to it in some media or human form. You in all probability will *never* learn it, lecture or not, without doing at least some of the work in these steps.

1. Review the whole (typically textbooks and/or notes)
2. Work on the parts (doing homework)

Let's examine these steps.

The first is pretty obvious. You didn't "get it" from one lecture. There was too much material if you were *lucky* and skillful and blessed with a good instructor you grasped it only for a *moment* but it is still flitting further and further away with every moment that passes. You need to review the entire topic, as a whole, as well as all its parts. A set of good summary notes might contain all the relative factoids, but there are *relations* between those factoids – a temporal sequencing, mathematical derviations connecting them to other things you know, a topical association with other things that you know. They tell a *story*, or part of a story, and you need to know that story in broad terms even if you can't remember every word.

Reviewing the material should be done in layers, skimming the textbook and your notes, creating a *new* set of notes out of the text in combination with your lecture notes, maybe reading in more detail to understand some particular point that puzzles you, reworking a few of the examples presented.

You do *not have* to work on *memorizing* the content. In fact, it is not desireable to try to memorize content at this point – you want the big picture *first* so that facts have a place to live in your brain.

Your brain is fabulously efficient at storing information in a compressed associative form. There are lots of experiments that demonstrate this – the simplest being trying to memorize a string of ten or so numbers at a glance (more than the 7 one can typically get into short term memory).

Try memorizing 1357902468 from just the *one* glance you got reading this sentence. No fair going back and repeating it to yourself, at least while looking at it! Now look at it and try to remember it. One strategy is to just repeat it to yourself until you get it right, but if you stare at it a while and *think*, you'll see that it has a very simple pattern embedded in it.

In fact, this number "compresses" to a single two-step rule – all the odd digits in ascending order followed by all the even digits ditto. You *already know* what a "digit" is, what odd and even numbers are, what ascending versus descending order is. You only need to remember "ascending" and "odd followed by even digits" – everything else is compressed.

This ability to compress goes far beyond what I can explain or you can easily imagine. When I play a game of chess, I've forgotten my first five moves by the time I've made my tenth move. By the time the game finishes, I have no idea how I got into the mess I'm probably in. A chess master, on the other hand, can *finish* the game and then can recontruct the *entire game* in order, and can criticize each move as they do so. In fact, they can probably remember the entire game they played yesterday, or the one they played last week. They've built a complex structure of associative memory so that they don't remember moves the same way your or I do.

On the other hand, I can often remember what mistakes a student of mine made a week after grading one of their papers. I many not remember the student's *name* (no good associative memory there) but I've got great structures for remembering how to solve or not solve physics problems.

This is the goal of your iterated review process. At first you are memorizing things the hard way, trying to connect what you learn to very simple hierarchical concepts such as this step comes before that step. As you do this over and over again, though, you find that new information takes you less and less time. Sometimes your right brain even figures something out and passes it off to your left brain, which "discovers" a missing part of the structure before you even read about it. By reviewing the whole, well-organized structure over and over again, you gradually build a greatly compressed representation of it in your brain and tremendously reduce the amount of work required to flesh out that structure with increasing levels of detail *and remember them* for a long, long time.

Now let's understand the second part of doing homework – working problems. As you can probably guess on your own at this point, there are good ways and bad ways to do homework problems. The worst way to do homework (aside from not doing it at all, which is far too common a practice as it is) is to do it all in one sitting, right before it is due, and to never again look at it.

It is left as a *homework exercise* for the student to work out why this is a bad idea from the discussion and facts given above. Let's see, it fails to repeat the material (essential for turning short term memory into long term in all cases). It exhausts the neurons, as one often ends up working on a problem far too long in one sitting just to get done. It fails to incrementally build up in your brain's long term memory the structures upon which the solution is based, so you have to constantly go back to the book to get them into short term memory long enough to get through a problem. Unfortunately, by not repeating they soon fade, often without a discernable trace in long term memory.

Just as was the case with memorizing the number above, the problems almost invariably are *not* going to be a matter of random noise. There is pattern and meaning there, but it takes time and repetition for the "gestalt" of it to spring into your awareness and burn itself into your conceptual memory is high order understanding. You have to give it time, and perform the repetitions.

You don't get strong by lifting light weights a single time. You get strong lifting heavy weights repeatedly. As with the body, so with the brain.

The following "Method of Three Passes" is a strategy for doing homework, especially problem oriented homework, that will pay off big in learning dividends should you adopt it.

4 The Method of Three Passes

Pass 1 Three or more nights before recitation, make a *fast* pass through all problems. Plan to spend 1-1.5 hours on this pass. With roughly 10-12 problems, this gives you around 6-8 minutes per problem. Spend *no more* than this much time *per problem* and if you can solve them in this much time fine, otherwise move on to the next. Try to do this the last thing before bed at night and *then go to sleep.*

Pass 2 After at least one night's sleep, make a *medium speed* pass through all problems. Plan to spend 1-1.5 hours on this pass as well. Some of the problems will already be solved from the first pass or nearly so. *Quickly* review their solution and then move on to concentrate on the still unsolved problems. If you solved 1/4 to 1/3 of the problems in the first pass, you should be able to spend 10 minutes or so per problem in the second pass. Again, do this right before bed if possible and then go immediately to sleep.

Pass 3 After at least one night's sleep, make a *final* pass through all the problems. Begin as before by quickly reviewing all the problems you solved in the previous two passes. Then spend fifteen minutes or more (as needed) to solve the remaining unsolved problems. Leave any "impossible" problems for recitation – there should be no more than three from any given assignment, as a general rule. Go immediately to bed.

This is an *extremely powerful* prescription for deeply learning nearly *anything*. Here is the motivation. Memory is formed by repetition, and this obviously contains a lot of that. Permanent (long term) memory is actually formed in your sleep, and studies have shown that whatever you study right before sleep is most likely to be retained. Physics is actually a "whole brain" subject – it requires a synthesis of both right brain visualization and conceptualization and left brain verbal/analytical processing – both geometry and algebra, if you like, and you'll often find that problems that stumped you the night before just solve themselves "like magic" on the second or third pass if you work hard on them for a short, intense, session and then sleep on it. This is your right (nonverbal) brain participating as it develops intuition to guide your left brain algebraic engine.

Other suggestions to improve learning include working in a study group for that third pass (the first one or two are best done alone to "prepare" for the third pass). Teaching is one of the best ways to learn, and by working in a group you'll have opportunities to both teach and learn more deeply than you would otherwise as you have to articulate your solutions.

Make the learning *fun* – the *right* brain is the key to forming long term memory and it is the seat of your *emotions*. If you are happy studying and make it a positive experience, you will increase retention, it is that simple. Order pizza, play music, make it a "physics homework party night".

Use your whole brain on the problems – draw lots of pictures and figures (right brain) to go with the algebra (left brain). Listen to quiet music (right brain) while thinking through the sequences of events in the problem (left brain). Build little "demos" of problems where possible – even using your hands in this way helps strengthen memory.

Avoid "memorization". You will learn physics far better if you learn to *solve* problems and *understand* the concepts rather than attempt to *memorize* the umpty-zillion formulas, factoids, and specific problems or examples covered at one time or another in the class.

Be sure to review the problems one last time when you get your graded homework back. Learn from your mistakes or you will, as they say, be doomed to repeat them.

If you follow this prescription, you will have seen *every assigned homework problem* a minimum of five or six times – three original passes, recitation itself, a final write up pass after recitation, and a review pass when you get it back. At least three of these should occur after you have solved *all* of the problems correctly, since recitation is devoted to ensuring this. When the time comes to study for exams, it should really be (for once) a *review* process, not a cram. Every problem will be like an old friend, and a very brief review will form a *seventh* pass or *eighth* pass through the assigned homework.

With this methodology (enhanced as required by the physics resource rooms, tutors, and help from your instructors) there is no reason for you do poorly in the course and every reason to expect that you will do well, perhaps very well indeed! And you'll still be spending only the 3-6 hours/week on homework that is expected of you in any course of this level of difficulty!