Physics 132 Physics for Biologists II

Physics for Biologists II

Description and Prerequisites

This course is intended for biology majors and pre-health care professionals. The physics topics chosen are selected for these students and the contexts emphasize authentic biological examples. Prerequisites for the course include:

- One year of college biology (BSCI 105 and 106 or the equivalent)
- One semester of college chemistry (CHEM 131 or the equivalent)
- One year of college mathematics (MATH 130 and 131 or the equivalent -- calculus and an introduction to probability)

This is not your parent's physics! This class will focus on the physics relevant to living things from molecules to worms to woodpeckers. While physics, chemistry, and biology are well established fields, some of the scientific questions you will explore in this class have only recently been tackled. You will focus on physics at the convergence with biology, where physical, chemical and biological principles all come into play. A primary theme for this first semester is the concept of motion -- and the difference between coherent, directed motion and the random motion that occurs at the molecular level.

What do I need to buy?

There is no textbook to buy for this course. We are developing a WikiBook that you will be able to read online. There is also no lab manual to buy. The lab instructions will be made available online. You will need to have:

- **A Clicker** -- a remote control device from TurningPoint that allows you to contribute answers in lecture. It is available at the Campus Book Store. This is the campus standard. If you have one from another class, you are likely to able to use it here. If you have an iPhone or iTouch you should be able to use it as a clicker. See the campus clicker page for more information.

  After you have purchased a clicker or iphone/itouch clicker account please register it here: https://myelms.umd.edu/courses/1020311

- **Online HW service** -- HW will be done online through the online service, *Webassign*. You can expect it to cost between $25-$30 for each semester. For instructions on how to purchase this, download and follow the instrutions in the document, WebAssign Student Quick Start Guide. The Institution Code is "**umd**" and the Class Keys are
  - 010x (MWF): **8186 9129**
  - 020x (TuTh): **5830 8955**

What else do I need to get?

A lot of what we'll be doing this term will be on the computer. Our readings and our homework will be on canvas and webassign. You will also need access to a spreadsheet, and you will learn to download and use a video analysis program in labs. If you do not have your own laptop, you will need to seek out the campus computer rooms and find the places where you can access the appropriate programs. You need:

- **Access to a computer** -- if you have your own laptop you will be able to use that. If not, you will have to seek out campus computers that run the programs we will be using and to see our Announcements and to track your grades on Canvas.
- **A Spreadsheet** -- You can either use Excel or the spreadsheet available at Googledocs (http://docs.google.com/) to do repetitive calculations. If you plan to use Googledocs you will need to have a Google account (a free Gmail account will work.)
  For those of you who are unfamiliar with spreadsheets, there are a number of good tutorials on the web. These below look particularly appropriate. Many others are easily found by putting "Excel tutorial" into your favorite search engine. We will do our own training on Excel in the first lab.
  (http://phoenix.phys.clemson.edu/tutorials/excel/ ,http://www.excel-easy.com ,http://www.baycongroup.com/excel.htm)
- **A Video Analysis Program** -- You will learn how to quantitatively analyze images and videos. The tool we will use for this will be ***ImageJ***. This program is freely available, developed for use in biology and medicine at NIH, and is the professional standard. If you have your own laptop, we will help you install this in the laboratory period during the second week of class.

What do I need to do to succeed in this class?

Here is a brief outline of what you will need to do throughout the class. For more details, see the Course Mechanics page.

- ***Do the reading and commentary for each lecture and selected labs***! -- For each lecture and some labs there will be a required reading of a few web pages. For two of these you will be asked to summarize the page on your *Webassign* online homework program and ask a question about it. The lecture reading write ups will be due eight hours before the lecture class. You can find the lecture reading assignments on the Schedule Page for your instructor MWF (010x) or TuTh (020x) , and the Lab pre-readings under Recitation/Labs
- ***Attend and participate in all the lectures, recitations, and labs!*** -- This is a class very much about *doing*, not just about learning facts or equations. In lecture we will be doing very little lecturing but a lot of answering questions, doing group problem solving, and holding class discussions. You will get participation points for some of this stuff, but that's not the point -- the point is that in the *doing* in lecture and recitation, and in labs is where a lot of the real learning in this class takes place. A major part of what you will be learning is how to talk about and make sense of physics through problem solving with your classmates and by designing, doing and analyzing experiments in lab.
- ***Do the weekly homework!*** -- While the lecture and recitation is where you will learn to talk about and make sense of physics through problem solving, the homework is where you will get to try it out with your classmates on your own. You are encouraged to work with others. We have a Course Center (room 0208) set up, where you can find people to work with (and get help when you are stuck). **But be careful!** If you work together DO NOT create a common solution and everyone copy it. Once you have worked out a solution together, each person must write it up separately in your own words. If two solutions are too nearly identical, neither will get credit! Homework assignments themselves are found on our Homework Assignment page.
- ***Keep up!*** -- We know that you're busy, and in many other classes you can let things slide and then catch up for the exam. In this class that will be very difficult. Each lecture builds on the last, and on the homework from previous weeks. If you miss too much you may find yourself lost. In addition, your grade in this class is based on the accumulation of points in many different categories throughout the term. For details see our Course Mechanics page.

Times and Places

Event	010x	020x	Place
Lecture	MWF 10-10.50	TuTh 12.30-1.45	Physics 1412
Discussion	M11, Tu11, Tu2, W11, Th8, Th11	M2, M5, Tu8, W8, W2, Th2	Physics 3312
Laboratory	M12, Tu12, Tu3, W12, Th9, Th12	M3, M6, Tu9, W9, W3, Th3	Physics 3312

Instructors

Instructors	Name	Room	Phone	Office Hours	EMail
Instructor	Prof. D. Buehrle	PHY 1330	x5 6045	(in the Course Center 0208 or by arrangement at other times in 1330)	dbuehrle@umd.edu
Lead TA	Matthew Harrington	ERF 0300	x5 6368	in the Course Center 0208	mjharrin@umd.edu
TA	Alison Leonard	PHY 3103B	x5 6189	in the Course Center 0208	aleonar2@terpmail.umd.edu
TA	Hao Wu	PHY 0220	x5 5969	in the Course Center 0208	haowu@umd.edu
TA	Antonios Kyprianidis	PHY 3103B	x5 6189	in the Course Center 0208	ankypr@hotmail.com
TA	Erin Sohr	PHY 1322	x5 6185	in the Course Center 0208	erinsohr@gmail.com
TA	David Foote	CSS B0250	x5 4868	in the Course Center 0208	dbfoote@umd.edu
TA	Aaron Ostrander	PHY 3101	x5 6191	in the Course Center 0208	the.aaron.ostrander@gmail.com
Lab Developer	Kimberly Moore	PHY 1322	x5 6185	in the Course Center 0208	kmoore17@umd.edu
LA					
LA					
LA					
Slawsky Clinic		PHY 1214		10-3 MWF (1214)	

Honor code:

The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit this link. If you have any questions about policy or procedures, please feel free to ask. We are looking forward to working with you and hope that you will both enjoy and learn a lot from the class.

Disability arrangements:

Students who have arrangements for extra time on exams should check in with the instructor at the beginning of the class. In this class, arrangments will be made for extensions of time on site rather than at the DSS site. This is to account to permit the student to ask the instructor questions for occasional corrections or clarifications that are made during the exam period as the result of student questions.

Religious holidays and other excused absences:

This class follows campus policy for granting exemptions for religious holidays. For absences for illness, please email your professor stating the cause and date of your absence. For other potential absences, please consult your instructor.

Edited by D Buehrle January 2015

Physics 132 Physics for Biologists II

Course Mechanics & Grading

This class is an active learning experience! Think "aerobics class" rather than "watching a good science program on TV"! In all parts of the class you will be engaged in thinking about, talking about, figuring out, and learning physics.

Readings

There are readings in this class, but we have chosen not to use a standard text. In part this is because there is no standard introductory physics text that covers the physics that is most useful for applications in the life sciences. Our goal is to start with what you know from introductory biology and chemistry -- and your everyday experience! -- and teach you the physics that is most relevant for understanding living things. We are in the process of writing such a book as an online wiki-book. Before each class there will be a few (fairly short) web pages for you to read and comment on (using *Webassign*). Here are your pre-lecture tasks: MWF(010x) TuTh(020x)(If you would like to purchase and access a text, you can either add one to your WebAssign or purchase a paper copy. Ask your instructor for some recommendations.)

Classes

The "lectures" will typically begin with a brief recap of the content of the previous night's reading and a discussion based on the questions you and your classmates have entered. The rest of the class will be group problem solving, demonstrations and discussions, and other activities.

Recitations

The recitation sections will be group problem solving. Typically, you will work through an extended multi-part problem often with a biological context.

Homework

In addition to the reading commentaries there will be weekly homework assignments.

You will be asked to do 4-6 challenging problems including estimations, explanations, essay questions, worked out problems, and even some challenging multiple choice questions. You are encouraged to work on these with friends, but write up your solutions independently. Be careful: If two or more submitted answers are essentially identical, neither will receive credit. Some problems (1-2 per week) will be written out on paper and will be due at the BEGINNING of the last class of the week each week. The other problems will be due by 5pm and submitted through Webassign

Solutions to these problems will be posted on Canvas. You will need to go over those solutions carefully and compare to what you have done to be sure you understand.

Homework and in-class problem solving is where most of the learning in this class gets done! Do a careful and complete job on your homework. If you are not earning full credit and looking at the solutions doesn't help you for next time, check with an instructor and go over what more you need to do.

Quizzes

We will have (graded) 10-minute quizzes at the beginning of class on each **MONDAY** (010x) or **TUESDAY** (020x) when we are not going over an exam. They will consist of a number of questions projected on the screen and students will answer using their clickers. Quizzes will focus on important -- and sometimes subtle fundamental issues (often from the previous week's material). Each quiz will be worth 10 points. The point of these quizzes is to help you see where you might still be confused. There will tentatively be 11 quizzes. If we wind up having 11 without any missed days due to a weather emergency, the lowest grade will be dropped.

Exams

We will have two hour exams and a final. Each exam will test how well you have learned to use and make sense of the material. As a result, **you will be expected to think on exams.** Each exam will include (points approximate): one set of short answer or multiple choice problems (25 pts -- often connected representation translation problems), two multi-part problems (25 pts each -- problem solving), one estimation problem (15 pts), and an essay question (10 pts). Although exams are important, they total only ~40% of your grade -- and there are ways to improve your result after the fact. See below for the rules for regrades and makeup exams.

Laboratories

The laboratories in this class will let you experience and explore the topics of lecture and recitation in the real world. You also will learn techniques that are directly applicable to living things, for example how to characterize the motion of an object moving under a microscope.

The lab experiments are different from the traditional "protocol" labs where you are told exactly what to do and expect to get a result that agrees with some theoretical prediction. These are *design labs* -- labs in which your job is to design and carry out an experiment to answer a question.

Each lab experiment will be carried out over two or more weeks to give you time to learn a new technique and to answer a question. An important part of the lab is a discussion at the end where you present and discuss your results to the other members of your class.

Lab reports will be done during the lab periods and handed in before you leave the final lab period of an experiment. For more details and for the lab handouts, go to our Lab page.

Excuses

If you have a valid excuse for missing an exam, quiz, or homework, send an email to your instructor to arrange what to do about it, beforehand if at all possible. Specify the date and day you will be (or were) absent and the reasons. *Ex post facto* (after the fact) excuses will require validation and may not be acceptable. (Wanting to leave early before a holiday is NOT a valid excuse, even if it's for a friend's wedding.) You must contact your lead instructor. Your TA does not have the authority to excuse you from any required class activity.

Grading

Grades in this class arise from a mix of many different ways to judge your work, NOT solely from your performance on exams. Be sure you understand the components!

The result is a grade that is a more accurate representation of your performance in the class. It also means that you can blow one midterm exam and still get an A if your work in other categories is first rate! Here is the breakdown. It also means if you do very poorly on any one category -- say you don't hand in any homework -- it can be difficult to get a decent grade!

- ***Components*** --

Hour exams (100 pts each)	200
Quizzes	100
Final exam	200
Homework	300
Lab	165
Lecture Participation	80
Recitation/Lab Participation	75
Pre-Class and Pre-Lab Reading	80
Total	**1200**

These divisions are not guaranteed. We may adjust due to unforseen circumstances that cancel classes or HW - snow, tornadoes, etc.

- ***How grades are assigned*** -- We assign a grade level for each category (e.g., how many points you need to get to get an A on the quizzes, what you need to get an A on the HW, etc.) and then add up the points for each grade level to obtain what is need for each final grade. We anticipate that the top third of each grade range will be "+" and the bottom third will carry a "-".

- ***Curving: Labs and HW yes, exams and quizzes no*** -- For exams, we do NOT grade on a curve. We have an absolute expectation. On most exams, 75% will be an A, 60% a B, 45% a C. **This means that someone else's doing well on an exam will never negatively affect your grade. If you all do well on an exam we will give you all A's for that exam.**

- ***Exams*** -- Exam problems will not be standard end-of-chapter problems. You will be expected to think, not recall previously memorized information. Questions of the type found on our exams will be included in the homework problems and problems from previous exams will be available on our web site.

  - ***You can improve an exam grade 1: Regrades*** -- Since we go over midsemester exams in class, you will be able to get a good sense of how it was graded. If you think the grader misunderstood what you were saying, or failed to give you proper credit, you can apply to your lead instructor for a regrade by writing a clear description of why you think you should have more points and turning it in with your exam. In addition to grading error, if you can make a case that you made an early error, but correctly carried out later parts that depended on that error, you can request consistency points. Again, you will have to explain carefully in writing your argument.

    Be sure not to write on your exam itself since this will mean we would have to look up the scanned exams to see what you originally wrote. If you alter a graded exam and request a regrade we will automatically report it to the honor committee. Don't do it!

- ***You can improve an exam grade 2: Makeup exams*** -- Each midterm exam will be followed by a makeup exam on the Friday a week after the exam, in the late afternoon. If you miss a midterm, you must take the makeup. If you are unhappy with your grade on an exam, you may take the makeup. If you take both the original and makeup exams, your grade for that exam will be the average of the two grades (whether you do better or worse). In our experience, students who carefully consider their errors and understand what they did wrong on the first exam almost always improve. Students who don't do this and just "take another shot" and "study some more" are as likely to go down as to go up.

- ***Equation sheets on exams? No!*** -- Equation sheets will not be permitted on exams. This is NOT because we want you to memorize all the equations, but because if you focus on lots of equations you will miss making sense of the physics. We will expect you to know some equations -- but only a few; and they should make sense to you and be easy to remember. Exam problems will NOT be simple plug-and-chug applications of equation calculations but will require thinking and, on some questions, writing.

- ***Overall grades*** -- From past experience, we expect that an A will require about 960 points, a B will require about 850 ± 30 points and a C will require about 700 ± 30 points. Passing (not getting an F) will require about 600± 30 points. These grades reflect that the average points needed for a grade level on the homework and labs tend to be higher than on the exams. (The "±" ranges are not guaranteed but are standard deviations -- our best estimate for the range that the result will fall in 2 times out of 3.)

Edited by D. Buehrle January 2015

Physics 132 Physics for Biologists II

- 132 Home
- Mechanics/Grading
- Schedule TuTh
- Homework
- Recitation/Labs

Schedule -- MWF (010x)

You can find an overview of the readings for this class (plus readings I am not assigning) at: Working Content II

Notes: This schedule is tentative and subject to change. For **BOLD** Reading Assignments, you need to write a summary and ask a question online in Webassign. This is due 10 PM the previous evening.

The content column links to slides from the PowerPoint presentation used in class. They will be posted either **just before or just after the class takes place**. Note that these slides only represent a skeleton of the presentation and do not include solutions to problems and questions posed, derivations, or representations of class discussions. If you miss a class, these notes do not suffice to fill you in on what happened! Be sure to check with someone who actually attended. The files are Adobe PDF files.

Date	Class	Reading	Content	Quiz
Week 1				
1/26	1	1.Introduction to the class 1.1The disciplines: Physics, Biology, Chemistry, and Math 1.1.1Science as making models 1.1.4What Physics can do for Biologists 1.2 Thinking about Thinking and Knowing 1.2.1 The nature of scientific knowledge	Introduction to the Class	
1/28	2	**6.4.2 Atomic and Molecular forces**	Physics Perspective on Chemical Bonds	
1/30	3	**6.4.1 Energy at the sub-molecular level**	Physics Perspective on Chemical Energy	
Week 2				
2/2	4	Interlude 2: The Micro to Macro Connection **7. Thermodynamics and Statistical Physics** 7.1 Kinetic theory: the ideal gas law	First Law	**Quiz 1**

		7.2 The 1st law of thermodynamics		
2/4	5	7.2.1 Organizing the idea of energy **7.2.2 Enthalpy**	Energy Sharing and Distributions	
2/6	6	**7.2.3 Thermodynamic equilibrium and equipartition** **7.3.1 The 2nd law of thermodynamics: a probabilistic law**	Energy Sharing and Distributions	
Week 3				
2/9	7	7.3 The 2nd law of thermodynamics **7.3.2 Implications of the second law of thermodynamics: entropy** 7.3.2.1 Why entropy is logarithmic 7.3.2.2 Consequences of the second law of thermodynamics	Entropy	**Quiz 2**
2/11	8	7.3.2.3 A way to think about entropy -- sharing **7.3.2.4 Entropy and heat flow**	Second Law of Thermodynamics	
2/13	9	7.3.3 Free energy **7.3.3.1 Motivating the Gibbs free energy** **7.3.3.2 Gibbs free energy**	Free Energy	
Week 4				
2/16	10	7.3.4 How energy is distributed **7.3.4.1 Boltzmann distribution** **7.3.4.2 Boltzmann distribution and Gibbs free energy** 7.3.4 How energy is distributed	Boltzmann Distribution & Wrapping up Thermodynamics	**Quiz 3**
2/18	11	4.2.4 Electric forces **4.2.4.1 Charge and the structure of matter** **4.2.4.2 Polarization** 4.2.4.3 Coulomb's law	Electric Charge	
2/20	12	**4.2.4.3.1 Coulomb's law -- vector character** 4.2.4.3.2 Reading the content in Coulomb's law **4.2.4.4 The electric field**	Electric Force	
Week 5				
2/23	13	**8.1 The electric field** 8.1.1 The concept of field (technical) **8.1.2 Making sense of the idea of field**	Electric Fields	**Quiz 4**
2/25	14	Review for Exam1	Review	
2/27	15	No HW due	**EXAM 1**	
Week 6				
3/2	16		Go over exam	
3/4	17	**8.2 The electric potential** **8.2.1.1 A simple electric model: a line of charge**	Electrostatic potential	

		8.2.1.1.1 Line charge integral (technical) **8.2.1.2 A simple electric model: a sheet of charge**		
3/6	18	**8.4.2 The capacitor**	Capacitors	
Week 7				
3/9	19	**8.5 Electric current** **8.5.1 Quantifying electric current** **8.5.2 Resistive electric flow: Ohm's law**	Moving Charges: Current	**Quiz 5**
3/11	20	**8.5.3 Ways to think about current: A toolbox of models** **8.5.4 Kirchoff's principles**	Kirchoff's principles	
3/13	21	8.5.4.1 Applying Kirchoff: Examples **8.5.5 Electrical energy and power**	Electrical energy and power	
Week 8				
3/23	22	**8.3.1 Screening of electrical interactions in salt solution** **8.3.1.1 Debye length**	Electrical Interactions in Fluids	
3/25	23	**8.3.2 Nernst potential**	The Nernst Potential	
3/27	24	**9. Oscillations and Waves** **9.1 Harmonic Oscillation**	Oscillation	
Week 9				
3/30	25	**9.1.1 Mass on a spring** 9.1.1.1 Hanging mass on a spring **9.1.1.2 The pendulum**	Simple Harmonic Oscillators	**Quiz 6**
4/1	26	**9.1.2 Damped Oscillators** 9.1.2.1 Damped oscillators - the math (technical) **9.1.3 Driven harmonic oscillators: resonance** 9.1.5 Quantum Oscillators -- discrete states	Damped Harmonic Oscillators	
4/3	27	**9.2 Waves in 1D** 9.2.1 Waves on an elastic string 9.2.2 Wave pulses 9.2.2.1 Propagating a wave pulse - the math	One Dimensional Waves	
Week 10				
4/6	28	Review for Exam 2	Review 2	**Quiz 7**
4/8	29		**EXAM 2**	
4/10	30		Go over exam	
Week 11				
4/13	31	**9.2.3 Wave speed** **9.2.4 Superposition of waves in 1D**	Waves	

4/15	32	**9.2.5 Sinusoidal waves**	Superposition	
4/17	33	**9.3.1 The nature of sound** **9.3.2 Analyzing sounds**	Standing Waves & Sound	
Week 12				
4/20	34	**10 Three models of light** **10.1 The ray model of light**	Ray model of light	**Quiz 8**
4/22	35	**10.1.1 Basic principles of the ray model** **10.1.2 Flat mirrors**	Reflection	
4/24	36	**10.1.3 Curved mirrors** 10.1.3.1 Curved mirror equations	Mirrors	
Week 13				
4/27	37		Refraction	**Quiz 9**
4/29	38	**10.1.4 Lenses** 10.1.4.1 Lens equations 10.1.5 The eye 10.1.6 Optical instruments	Lenses	
5/1	39	**10.2 The wave model of light** 10.2.1 Electromagnetic radiation and Maxwell's rainbow **10.2.3 Two-slit interference**	Wave Model of Light	
Week 14				
5/4	40	**10.2.4 Diffraction** 10.2.4.1 Interference from two wide slits	Diffraction	**Quiz 10**
5/6	41	**10.3 The photon model of light** **10.3.1 Basic principles of the photon model** 10.3.1.1 Reconciling the wave and photon model - sort of	Photon Model of Light	
5/8	42	**10.4 Color and light** 10.5 Interactions of light with matter **10.5.1 Visual implications**	Quantization	
Week 15				
5/11	43		Semester Review	**Quiz 11**
Final Exam				
TBA	Time: TBA		Location:	TBA

Edited by D Buehrle January 2015

Physics 132 Physics for Biologists II

- 132 Home
- Mechanics/Grading
- Schedule MWF
- Homework
- Recitation/Labs

Schedule -- TuTh (020x)

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Notes: This schedule is tentative and subject to change. Reading Assignments are online; commentary in WebAssign is due 10 PM the evening prior to the lecture.

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1/29	2	**6.4.1 Energy at the sub-molecular level** **6.4.2 Atomic and Molecular forces**	Physics Perspective on Chemical Energy	
Week 2	:			
		Interlude 2: The Micro to Macro Connection **7. Thermodynamics and Statistical Physics** 7.1 Kinetic theory: the ideal gas law		**Quiz**

2/3	3	**7.2 The 1st law of thermodynamics** 7.2.1 Organizing the idea of energy **7.2.2 Enthalpy**	First Law	**1**
2/5	4	**7.2.3 Thermodynamic equilibrium and equipartition** **7.3.1 The 2nd law of thermodynamics: a probabilistic law**	Energy Sharing and Distributions	
Week 3				
2/10	5	7.3 The 2nd law of thermodynamics **7.3.2 Implications of the second law of thermodynamics: entropy** 7.3.2.1 Why entropy is logarithmic 7.3.2.2 Consequences of the second law of thermodynamics 7.3.2.3 A way to think about entropy -- sharing **7.3.2.4 Entropy and heat flow**	Entropy & Second Law of Thermodynamics	**Quiz 2**
2/12	6	7.3.3 Free energy **7.3.3.1 Motivating the Gibbs free energy** **7.3.3.2 Gibbs free energy**	Free Energy	
Week 4				
2/17	7	7.3.4 How energy is distributed **7.3.4.1 Boltzmann distribution** **7.3.4.2 Boltzmann distribution and Gibbs free energy**	Boltzmann Distribution & Wrapping up Thermodynamics	**Quiz 3**
2/19	8	4.2.4 Electric forces **4.2.4.1 Charge and the structure of matter** **4.2.4.2 Polarization** 4.2.4.3 Coulomb's law **4.2.4.3.1 Coulomb's law -- vector character** 4.2.4.3.2 Reading the content in Coulomb's law **4.2.4.4 The electric field**	Electric charge, force, and energy	
Week 5				
2/24	9		Fields: Examples and some simple models	**Quiz 4**
2/26	10	Review for Exam 1	**EXAM 1**	
Week 6				
3/3	11	**8.1 The electric field** 8.1.1 The concept of field (technical) **8.1.2 Making sense of the idea of field** **8.2 The electric potential** **8.2.1.1 A simple electric model: a line of charge** 8.2.1.1.1 Line charge integral (technical)	Electrostatic potential	

		8.2.1.2 A simple electric model: a sheet of charge		
3/5	12	8.4 Capacitance 8.4.4 Two parallel plates **8.4.2 The capacitor**	Capacitance	
Week 7				
3/10	13	**8.5 Electric current** **8.5.1 Quantifying electric current** **8.5.2 Resistive electric flow: Ohm's law** **8.5.3 Ways to think about current: A toolbox of models**	Moving Charges: Current	**Quiz 5**
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3/26	16	**9. Oscillations and Waves** **9.1 Harmonic Oscillation** 9.1.1 Mass on a spring 9.1.1.1 Hanging mass on a spring	Harmonic Oscillation	
Week 9				
3/31	17	**9.1.1.2 The pendulum** **9.1.2 Damped Oscillators** 9.1.2.1 Damped oscillators - the math (technical) **9.1.3 Driven harmonic oscillators: resonance**	Damped Oscillation	**Quiz 6**
4/2	18	9.1.5 Quantum Oscillators -- discrete states **9.2 Waves in 1D** 9.2.1 Waves on an elastic string 9.2.2 Wave pulses 9.2.2.1 Propagating a wave pulse - the math **9.2.3 Wave speed** **9.2.4 Superposition of waves in 1D**	Waves	
Week 10				
4/7	19	Review for Exam 2	Catching up/ Review	**Quiz 7**
4/9	20	Review for Exam 2 -Sample Questions Key	**EXAM 2**	
Week 11				

4/14	21	**9.2.5 Sinusoidal waves** 9.2.6 Summing different wavelengths -- spectral analysis 9.3 Sound waves **9.3.1 The nature of sound** **9.3.2 Analyzing sounds**	Sinusoidal Waves	
4/16	22	9.2.4.2 Standing waves	Standing Waves	
Week 12				
4/21	23	**10 Three models of light** **10.1 The ray model of light** **10.1.1 Basic principles of the ray model**	Ray Model of Light	**Quiz 8**
4/23	24	**10.1.2 Flat mirrors** **10.1.3 Curved mirrors** 10.1.3.1 Curved mirror equations	Mirrors	
Week 13				
4/28	25		Refraction	**Quiz 9**
4/30	26	**10.1.4 Lenses** 10.1.4.1 Lens equations	Lenses	
Week 14				
5/5	27	**10.2 The wave model of light** 10.2.1 Electromagnetic radiation and Maxwell's rainbow 10.2.2 Huygens' principle and the wave model 10.2.2.1 The math of Huygens' principle **10.2.3 Two-slit interference** **10.2.4 Diffraction** 10.2.4.1 Interference from two wide slits	The Wave Model	**Quiz 10**
5/7	28	**10.3 The photon model of light** **10.3.1 Basic principles of the photon model** 10.3.1.1 Reconciling the wave and photon model - sort of **10.4 Color and light** 10.5 Interactions of light with matter **10.5.1 Visual implications**	The Photon Model	
Week 15				
5/12	29		Course Review	**Quiz 11**
Final Exam				
TBA	Time: TBA		Location:	TBA

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Physics 132 Physics for Biologists II

- 132 Home
- Mechanics/Grading
- Schedule MWF
- Schedule TuTh
- Recitation/Labs

Homework

The weekly homework assignment is in Webassign. Please note that WebAssign has some quirky rule for what can be entered where. If it is not accepting your answer check out: Answers that cannot be understood. Please follow the instructions for the problems that are given *in the WebAssign environment*. The links below are to public forms of the problem and may not include specialize WebAssign instructions.

You will be asked to do 3-5 challenging problems including estimations, explanations, essay questions, worked out problems, and even some challenging multiple choice questions. You are encouraged to work on these with friends. **The Course Center is good space to work together and get feedback from a TA or Professor. CLICK FOR THE COURSE CENTER SCHEDULE.**

You have to write up your solutions independently. Be careful: If two or more submitted answers are essentially identical, neither will receive credit. Online homework is due by Friday 5pm for both sections of the class.

Some problems (1-2 per week) will be written out on paper and will be due at the BEGINNING of the last class of the week each week. Paper homework will be scanned; therefore, the homework that you turn in on paper should meet the following guidelines: No staples, paper clips, dog ears, etc. At the top of EVERY PAGE, write your name, professor's name, section number, and "Page x of y" (e.g. "Page 2 of 5"). The quality of the presentation will be considered in the score as well as the quality of the solution.

Scores for webassign part of homework will be kept on webassign. Scores for the paper HW will be kept on canvas. It will not be possible to submit "show your work" attachments for webassign questions - you will have to explain your answers in the textboxes provided.

Here is a translation guide to the Universal Grading Codes that will be used in grading the homework, so that you can understand the comments that you get back on your homework.

Due date (Fri)	Online HW (due at 5 PM)	Paper Hand in HW (due Beginning of Class)
2/6 HW 01	1. CLPhys1 10.P.038 (5 pts) 2. CLPhys1 10.P.006 (6 pts) 3. Chemical Bonds (3 pts) 4. Potential energy analogs for chemical reactions (8 pts) 5. Chemical Reaction Toy Model (3 pts) 1. CLPhys1 19.P.025 (3 pts) 2. CLPhys1 20.P.010 (1 pt)	Structure of the Lennard-Jones Potential (10 pts)

2/13 **HW 02**	3. CLPhys1 20.P.017 (1 pt) 4. Scales in a gas (4 pts) 5. Evaporating a membrane (4 pts) 6. Kinetic theory (5 pts)	Polymer entropy (10 pts)
2/20 **HW 03**	1. Population growth (5 pts) 2. Spontaneous change (2 pts) 3. Free expansion (8 pts) 4. Microscopics of ankle sprain (5 pts)	Workin and Actin (7 pts)
2/27	No Homework this week	No Homework this week
3/6 **HW 04**	1. CLPhys1 23.P.039 (5 pts) 2. CLPhys1 23.P.016 (2 pts) 3. Analyzing Dipoles (8 pts) 4. Another problem on Charges, Fields, and Potentials (6 pts)	Charges, Fields and Potentials (10 pts)
3/13 **HW 05**	1. CLPhys1 28.P.016 (2 pts) 2. CLPhys1 28.P.039 (2 pts) 3. CLPhys1 28.P.063 (2 pts) 4. Capacitance Dimension (8 pts) 5. Capacitance in nerve cells (7 pts)	Fields in a membrane (10 pts)
3/27 **HW 06**	1. CLPhys1 26.P.005 (1 pt) 2. CLPhys1 27.P.014 (8 pts) 3. Constant current source (6 pts)	1. Tracking around a circuit (6 pts) 2. Defibrilators (6 pts)
4/3 **HW 07**	1. CLPhys1 16.P.003 (6 pt) 2. CLPhys1 16.P.026 (4 pts) 3. The online mass-spring lab (8 pts) 4. Where's the force? (4 pts) 5. SHO Energies (6 pts)	Don't miss a beat (10 pts)
4/10	No homework this week	No homework this week
4/17 **HW 08**	1. CLPhys1 17.P.036 (1 pt) 2. CLPhys1 17.P.029 (3 pt) 3. CLPhys1 18.P.039 (1 pt) 4. Fourier construction of wave shapes (8 pts)	Propagating a Gaussian pulse (10 pts)
4/24 **HW 09**	1. Modified harmonics (4 pts)	The Resonance Simulation (10 pts)
5/1 **HW 10**	1. CLPhys1 35.P.012 (1 pt) 2. CLPhys1 35.P.030 (10 pt) 3. On the mirror (5 pts)	The microscope (10 pts)
5/8 **HW 11**	1. Modeling color: chromophores (9 pts) 2. Breaking up is hard to do (8 pts) 3. ATP hydrolysis (6 pts) 4. Hearing and seeing around a corner (6 pts)	X-ray crystallography (10 pts)

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Physics 132 Physics for Biologists II

- 132 Home
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- Homework

In our Physics for Future Biologists Labs you will

- learn physics relevant to microscopic and living systems;
- use 21st century physics tools and software;
- deal with data-rich environments; and
- learn how to design your own experiment and interpret data.

The laboratories are held in a community lab style that will allow you to work together in groups of 4 students on experiments. More information on the community lab style, including information on how the labs will be graded can be found at this LINK.

Attendance at every lab is required. If you anticipate missing a lab session, try to arrange ahead of time to attend another lab section (morning or afternoon) for that session (for a 1 week lab) or for the entire lab unit (for a 2 week lab). If it is not possible to attend a different lab session, contact your TA as soon as you are aware of your impending absence. Only those with a VALID WRITTEN EXCUSE for missing a lab will be allowed to do a makeup activity at the end of the semester (that will take at least two hours and may involve doing another lab or evaluating data). If you do not have a valid written excuse, you will get a zero for the week that you missed. You may make up a maximum of one excused absence. If you miss more than two weeks (have more than two 'zeros', i.e., if you miss more than two lab sessions), you may receive an incomplete or a failing grade for the entire class.

Laboratories will cover 6 experiments, five of them lasting 2 weeks, one lasting 1 week. At the end of each experiment you will work in the lab to finish a laboratory report and present your findings (and ideas for followup experiments) to the other laboratory working groups.

There will be pre-readings for some laboratories that you will be able to access through webassign just like the regular readings.

The **recitation sections** will be group problem solving. Typically, you will work through an extended multi-part problem often with a biological context.

Week of	Recitation	Lab Topic	Pre-Lab Reading
1/26	NO RECITATION	NO LAB	1. ImageJ Download Instructions for Students 2. Intro to Scientific Community Labs
2/2	How a kinesin walks	Modeling Fluid Flow, I	1. Quantifying Fluid Flow 2. Internal Flow -- the HP Equation

2/9	Entropy and diffusion	Modeling Fluid Flow, II	
2/16	Insane in the membrane, part 1: Oil and water	Analyzing electric forces in a fluid, I	Viscosity
2/23	Insane in the membrane, part 2: Lipid bilayers	Analyzing electric forces in a fluid, II	Electrokinetics and Colloid Behavior & The Double Layer
3/2	What is "free" about free energy?	Modeling signal transmission along nerve axons, I	1. Kirchoff's Principles (2013) 2. Resistive Electric Flow & Ohm's Law (2013)
3/9	Salting out and denaturing DNA	Modeling signal transmission along nerve axons, II	
3/23	Intro to light	Geometric optics, I	
3/30	Diatomic vibrations	Geometric optics, II	
4/6	Spectroscopy: How does light interact with matter?	Analyzing light spectra and exploring implications for living systems, I Please wear bright, solidly-colored clothing for this lab. If you have sunglasses, please bring them. (We can figure out if the 'UV-blocking' lenses really work!)	1. Three Models of Light 2. Color and Light
4/13	Seeing Inside the Body	Analyzing light spectra and exploring implications for living systems, II	
4/20	Photosynthesis	Exploring complex absorption and emission in molecules	
4/27	Why do we see in the visible?	Makeup lab	

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