SYLLABUS

Meeting Times

Lectures: MWF
(Section .04) 11:40 PM - 12:30 PM
(Section .05) 1:40 PM - 2:30 PM
Room: Hugel Science Center 100
Office Hours: M 9:30 AM – 10:30 AM
T 11:00 AM - 12:00 PM
R 12:00 PM - 1:00 PM
**office hours will be in Hugel 028*

Contact Information

Professor: Paul Stonaha

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Course Overview:

This course is a calculus-based introduction to the foundations of physics - covering the fundamental constructs such as vectors, velocity, momentum, and energy - intended for students majoring in science or engineering. Our emphasis will be on identifying, understanding, and applying the fundamental principles of Newton's laws for linear, rotational, and periodic motion.

Learning Outcomes:

By the end of this course, you will be able to

- Understand, identify, and apply the fundamental principles of mechanics in a variety of physical situations.
- Apply qualitative and quantitative problem-solving skills to answer concrete questions and communicate your reasoning to others.
- Describe phenomena in the physical world using the language of mathematics including calculus concepts and vector quantities.
- Identify conserved quantities in a physical system and apply the corresponding conservation laws to extract information about that system.
- Engage in the process of *doing* physics, including such tasks as developing, testing, and evaluating models, graphing and interpreting experimental data, solving problems, and communicating results.
- Collect and analyze experimental data relevant to testing a hypothesis and evaluate whether the evidence supports, refutes, or leads to the revision of the hypothesis.

Key points in this syllabus:

- Attendance is mandatory
- Completing each weekly homework assignment requires submitting answers on *Mastering Physics* AND submitting handwritten work online (Moodle).
- Exams are a hybrid take-home / in-class style.

Prerequisites:

MATH 161 or permission of instructor

Course Text:

University Physics with Modern Physics, 15th ed. by Young and Freedman with *Modified Mastering Physics*

Modified Mastering Physics (Or simply *Mastering Physics*) is an online homework system, in which you are asked to solve problems and the system automatically grades. You must have access to *Mastering Physics* to complete homework assignments in this course.

The physics department has opted for Inclusive Access, which is a service that pre-purchases the book and homework access for you for the semester. Your student account will be charged by the registrar. You may opt-out of this service if you wish. You may request information regarding this service from Darrell Parry (parryd@lafayette.edu) at the Lafayette Bookstore. If you want to purchase the text book with Mastering Physics independently, you can buy it online at http://www.MasteringPhysics.com/

PERSONAL RECOMMENDATION: Buy a print version of an early edition (~11th) of the textbook as a reference book.

Course Policies:

Attendance is mandatory. A significant component of this course will involve in-class participation and in-class group problem solving; these activities are designed to help you better learn the material and, as such, require your presence in order to be effective. Working with others will help inform your problem-solving by bringing potentially disparate approaches/opinions to the table, forcing you to discuss and debate with one another as you work towards a common solution.

I encourage you to read/review the relevant sections of the text (as listed in the schedule) *before* class so that the material is not completely unfamiliar to you when we start discussing it together. There's good stuff in the book. Please use it.

I expect your phone to be set to silent during the class. If you have an ongoing emergency and need your phone with you during class, please set it to vibrate. ***You may not speak on the phone in the classroom during class time.*** If your phone causes repeated disturbances during the class, you will lose an attendance credit (at the professor's discretion).

You do not need to raise your hand to ask a question. Yes, you can go use the bathroom.

Grading:

Grades are determined on the following basis:

Attendance:	*See below*	Mid-term Exam I:	14%
Labs:	20%	Mid-term Exam II:	14%
Problem Sets:	20%	Mid-term Exam II:	14%
		Final Exam:	18%

Final Grade Scale:

Final grades are assigned according to the following breakdown.

	Must be at least …
A	93.5%
A-	89.5%
B+	86.5%
B	82.5%
B-	79.5%
C+	76.5%
C	72.5%
C-	69.5%
D+	66.5%
D	62.5%
D-	59.5%
F	< 59.5%

In my class, A grades are given to students who completed all homework assignments and *consistently* display excellence in critical thinking, quantitative analysis, and communication skills. A grade of A- is commonly given to students who have completed all homework assignments but do not consistently display all of the skills listed above.

The only students who fail my class are those who skip nearly all homework assignments and test questions.

Attendance:

Attendance is mandatory. You must arrive to class on time. You will start this course with 6 free 'attendance credits'. Every unexcused tardy shall cost you one (1) attendance credit. Every unexcused absence will cost you two (2) attendance credits. If you use up these credits, subsequent tardies and unexcused absences shall add to your *attendance demerits* (two for absences, one for tardies). Each attendance demerit will cost you 0.25% of your final grade. Your attendance score *sets a ceiling* for the maximum grade you can get in the class, and it does not contribute directly to the calculation of your grade. ***If you lose at least 10% of your grade due to this mechanism, it is an automatic course failure.***

*Example: From your labs, homework, and exams your grade is an 82%. You have 22 absences and 1 tardy. Your 'attendance grade' would be a 90.25%. At this point your final grade would be an 82% * 0.9025 = 74%. But one additional tardy or unexcused absence would cause you to fail the class outright.*

There will be a sign-in sheet at the beginning of each class meeting to help track attendance; please fill it out upon entering class with the provided pen. Excused absences (accompanied by a Dean's Excuse) will not be penalized.

Laboratory:

The laboratory is an essential part of this course. There you will see and experiment with many of the concepts we cover in class and learn how to approach, analyze, and communicate details of an experiment. You must complete all of the assigned experiments; you will be unable to pass this course unless you both complete all laboratory activities and receive a passing grade for the laboratory part of the course. Further details will be provided by your laboratory instructor.

The laboratories may seem 'dry'. To make the most from laboratory, you may need to adjust your mindset. Don't imagine the lab as busywork. Rather, imagine that you are testing a new hypothesis for the first time. You collect data to confirm or refute this hypothesis. Then, after collecting the data, you discover that someone else has already confirmed the hypothesis you were testing. You compare your data to the hypothesized model, to further confirm its accuracy.

Problem Sets:

Homework will be assigned on a weekly basis and will be due on Wednesdays at 5pm. If you need extra time to complete the homework, let me know before the due date. You may have three (3) extra 2-day extensions on homework assignments. These extensions may be stacked for a single assignment, but never split. If you do not submit a homework on time without contacting me about an extension first, you will receive a zero for that assignment. Please plan to manage your time accordingly.

You will turn in homework in two (2) ways: You will submit answers through the Mastering Physics website AND you will turn in your written work for the Mastering Physics problems to me. I would like you to submit photographs of your handwritten homework through Moodle. I will grade the written work by examining a randomly selected problem(s). The average grade on the written work will be multiplied by the Mastering Physics grade to produce each weekly homework grade. The written work will be graded as follows:

No work or illegible work	×	40%
Legible but not complete or correct	✓–	60%
Legible and (complete or correct)	✓	80%
Complete, correct, & legible	✓+	100%

This grading rubric may be broken into finer demarcations when appropriate (e.g. a simple error, missing units, etc. may result in a 90%).

A few notes about assigned problem sets:

- Write out the problem (or an abbreviated version containing all relevant information). Draw a picture/diagram if useful.
- Clearly work out the problem, commenting your work as you go. Solutions should never contain just the math; ***use words to describe what you are doing*** and to reference where in the text an equation came from and why it is relevant.
- Remember to keep track of units (by writing them out with all your calculations)! Do the units work out as you expect they ought to at the end of a problem? Dimensional analysis is the easiest check to ensure you have tackled the problem correctly.
- Box your final solutions or major milestones as you do the problem. This makes it easier for you to follow your own work when you look it over.
- Think about or comment on the significance of your answer. (Does it make sense? Is it what you expected? Why or why not?)
- Please see me if you have any questions about this! I know it seems a bit ridiculous listed out like this, but I promise that it will serve you well in the long run. Writing in science is different from the traditional humanities paper, but the point is the same: to clearly and effectively communicate something. This will help you to accomplish that, even with online assignments.

Example of a solved problem:

Statement of problem:
A gun is known to fire bullets at 275 m/s. By what angle above the horizontal should the gun be oriented to hit a level target 800 meters away? How long will the bullet be in the air? Write down the bullet's initial velocity vector in "unit vector" notation.
Ignore air resistance.

Known quantities:	Unknown quantities:	Equations:
$v_0 = 275\,\frac{m}{s}$	θ	$\Delta y = \frac{1}{2}at^2 + v_{0y}t$
$\Delta x = 800\ m$	t	$\Delta x = v_{0x}t$
$\Delta y = 0\ m$		
$a = g = -9.8\,\frac{m}{s^2}$		

The after the bullet leaves the gun, it will begin to accelerate downward. We want the net vertical displacement during the travel time to be zero.

First, solve for time using Δx equation:

$\Delta x = v_0 \cos(\theta)\, t$	Displacement w/o acceleration
$t = \dfrac{\Delta x}{v_0 \cos\theta}$	Solve for t. ⋆ *Eq.1* ⋆

Next, use time result in Δy equation:

$0 = \frac{1}{2}gt^2 + v_0 \sin(\theta)\, t$	Displacement w/ acceleration
$0 = \frac{1}{2}gt + v_0 \sin\theta$	Divide by t
$0 = \frac{1}{2}g\frac{\Delta x}{v_0 \cos\theta} + v_0 \sin\theta$	Substitute in Eq 1
$-\frac{1}{2}g\frac{\Delta x}{v_0} = v_0 \sin\theta \cos\theta = \frac{v_0}{2}\sin 2\theta$	Use identity $\sin\theta\cos\theta = \frac{1}{2}\sin 2\theta$
$\sin 2\theta = -g\frac{\Delta x}{v_0^2}$	Reorganize
$\theta = \frac{1}{2}\sin^{-1}\left(-g\frac{\Delta x}{v_0^2}\right)$	Solve for θ

$$\theta = \frac{1}{2}\sin^{-1}\left(9.8\frac{m}{s^2} \times \frac{800\ m}{\left(275\frac{m}{s}\right)^2}\right) \Rightarrow \boxed{\theta = 0.0519\ rad = 2.98°}$$

Substitute to get time:

$$t = \frac{\Delta x}{v_0 \cos\theta} = \frac{800}{275\cos 2.98°} = \boxed{2.91\ seconds}$$

Initial velocity vector:

$$\vec{v}_0 = v_{0x}\hat{x} + v_{0y}\hat{y} = v_0\cos\theta\,\hat{x} + v_0\sin\theta\,\hat{y}$$

$$= 275\,(\cos 0.0519\,\hat{x} + \sin 0.0519\,\hat{y})$$

$$= 275\,(0.9986\,\hat{x} + 0.05199\,\hat{y})$$

$$\boxed{\vec{v}_0 = 274.6\,\hat{x} + 14.29\,\hat{y}}$$

Exams

There will be three (3) in-class exams and a comprehensive final exam. Each exam will describe a situation comprising a collection of quantities for which you will determine expressions and/or values. I will provide you with the exam problems one (1) week before the exam date. During that week, you may work with each other and use any other resources to develop answers to the questions.

On the day of the exam, you will be asked to solve the same problems you were given in the previous week, but you must work alone and may not use any notes, books, etc. To receive full credit, you must show all work and ***convince me that you know how to solve the problem (not just that you know what the solution is).*** This must include *written explanations* describing your reasoning.

*** If you wish to use a programmable calculator on the exam, you must demonstrate to me that you have cleared all memory on the calculator before receiving your test (https://bit.ly/4aUW0JE). I will use the sign-in sheet to record who has cleared their calculator's memory. Use of a programmable calculator without having proven to me that you cleared its memory ahead of time will result in a zero grade on the test. ***

Here is the rubric I will use to grade test work:

Criteria and Rating	Excellent (4)	Good (3)	Acceptable (2)	Fair (1)	Poor (0)
Strategic Approach (S) 25%	Approach chosen is clearly shown & *clearly written.*	Valid approach with vague written explanaition.	Valid approach with NO written explanaition.	Invalid approach with NO valid written explanaition.	Little or no understanding of how to approach the problem.
Physics Concepts (P) 30%	Appropriate concepts that are fully understood (e.g. independent vector components), clearly stated & employed correctly.	Appropriate concepts that are mostly understood but employed with errors.	Appropriate concepts identified, but not employed or understood.	At least one concept identified but unable to demonstrate understanding.	Little or no understanding of physics concepts.
Mathematical Concepts (M) 30%	Correct starting equations; All mathematical steps are clearly shown and they flow easily toward the correct answer.	Correct starting equations. All mathematical steps are clearly shown but minor errors yield wrong answer. **OR** Correct starting equations with correct final result but the mathematical steps are hard to follow.	Correct starting equations. The mathematical steps are hard to follow and errors begin to impede application.	Can identify at least one equation, but unable to apply them.	Incorrect equations; demonstrates little or no understanding of mathematical concepts involved.
Answer (A) 15%	100% correct answer – analytically, numerically & conceptually.	Correct answer analytically, but not numerically.	Incorrect answer, but on the right path.	Unable to reach a correct answer on this path.	No answer.

Supplemental Instruction

SI leaders will be holding problem help sessions multiple times during the week. These sessions are useful ways to practice applying the physics we discuss in class and work through book examples. See the Moodle page for a list of SI hours and locations.

Academic Honesty:

I expect that you will abide by the "Principles of Intellectual Honesty" appearing in the Lafayette College Student Handbook. Posting homework or exam questions to an external site without my permission is a violation of the Academic Honesty Policy. The Physics department also has an Academic Honesty policy for rules regarding collaboration with others. This document is available on the Moodle page for this class. Please feel free to ask if you have any questions about this policy.

Accommodations:

In accordance with Lafayette College policy, reasonable academic accommodation and support services are available to students who have a documented disability. It is your responsibility to provide me with the appropriate paperwork from the Accessibility Services Office. More information is available at https://hub.lafayette.edu/.

Covid-19 Policy:

Masks are not required for healthy, non-exposed individuals in this course section. Lafayette College is following the CDC recommended guidelines for handling cases of exposure to / illness from Covid-19:

For students ***exposed to someone who has tested positive*** for COVID-19 (close contact):

- If asymptomatic, attend classes.
- Wear a mask for a full 10 days.
- Watch for symptoms. If feeling ill, isolate immediately except to get tested at Bailey Health Center. Students may also use self-supplied, at-home test kits. A minimum of two, preferably three, negative tests taken at least 24 hours apart is recommended.

For students who ***test positive*** for COVID-19:

- Isolate for a minimum of five days.
- Mask for 10 days.
- A standard Dean's Excuse will be given and the Office of Advising & Co-Curricular Programs will be notified.

Gender Inclusion:

This is a gender-inclusive classroom. I have been provided with a class roster and your legal names. I will gladly honor any requests to be addressed by a different name or pronoun than appears on the class. Please make me aware of any preferences.

Proper Usage of Course Materials & Classroom Recordings:

At Lafayette College, all course materials are proprietary and for class purposes only. This includes posted recordings of lectures, worksheets, discussion prompts, and other course items. Reposting such materials or distributing them through any means is prohibited. Such materials should not be reposted

or distributed through any means. You must request my permission prior to creating your own recordings of class materials, and any recordings are not to be shared or posted online even when permission is granted to record. If you have any questions about proper usage of course materials please ask me. Please also be in contact with me if you have any concerns with being recorded during the course.

Common Course of Study Outcomes Statement:

This course (and particularly the lab com- ponent) will promote the following outcomes for Natural Sciences (NS) within the Lafayette Common Course of Study:

- NS 1: Employ the fundamental elements of the scientific method in the physical and natural world by identifying and evaluating a testable scientific hypothesis.
- NS2: Create and evaluate descriptions and representations of scientific data via equations, graphs, tables, and/or models.

Moodle Privacy Statement:

Please note that Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Federal Credit Hour Compliance Statement:

Student work in this course is in full compliance with the federal definition of a four-credit hour course. Please see the Registrar's Office website (https://registrar.lafayette.edu/wp-content/uploads/sites/193/2013/04/ Federal-Credit-Hour-Policy-Web-Statement.doc) for the full policy statement.

Tentative Lecture Schedule and Associated Readings

Week	Lecture	Date	Topic	Section	Homework
1	1	Jan. 22	Introduction	Ch. 1:1	
	2	Jan. 24	Units & Problem Solving	Ch. 1:2-6	
	3	Jan. 26	Working with Vectors	Ch. 1:7-9	
2	4	Jan. 29	Position, Velocity, and Acceleration	Ch. 2:1-3	
	5	Jan. 31	Motion with Constant Acceleration	Ch. 2:4	PS 1 due
	6	Feb. 2	Free Fall	Ch. 2:5-6	
3	7	Feb. 5	2D (Projectile) Motion	Ch. 3:1-3	
	8	Feb. 7	Projectile Motion Practice	Ch. 3:3	PS 2 due
	9	Feb. 9	Newton's Laws & Inertial Reference Frame	Ch. 4:1-2	
4	10	Feb. 12	Superposition & Free Body Diagrams	Ch. 4:3-4	
	11	Feb. 14	Action/Reaction & Friction	Ch. 4:5, 5:3	PS 3 due
	12	Feb. 16	Ramps & Pullies	Ch. 5:2	
5	13	Feb. 19	Circular Motion	Ch. 3:4, 9:1-2	
	14	Feb. 21	Circular Motion Applications	Ch. 5:4	PS 4 due
		Feb. 23	**Exam I**	**Chs. 1-5.3**	
6	15	Feb. 26	Work & Kinetic Energy	Ch. 6:1-3	
	16	Feb. 28	Work & Power	Ch. 6:4	PS 5 due
	17	Mar. 1	Gravitational & Elastic Potential Energy	Ch. 7:1-2	
7	18	Mar. 4	Forces & Potential Energy	Ch. 7:3-4	
	19	Mar. 6	Momentum	Ch. 8:1-2	PS 6 due
	20	Mar. 8	Inelastic Collisions	Ch. 8:3	
		Mar. 11	**Spring Break**		
		Mar. 13			
		Mar. 15			
8	21	Mar. 18	Elastic Collisions	Ch. 8:4	
	22	Mar. 20	Center of Mass	Ch. 8:5	PS 7 due
	23	Mar. 22	Rotational Kinematics	Ch. 9:3	
9	24	Mar. 25	Rotational Energy & Moments of Inertia	Ch. 9:4-5	
	25	Mar. 27	Torque	Ch. 10:1-3	PS 8 due
		Mar. 29	**Exam II**	**Chs. 5.4-8**	
10	26	Apr. 1	Rotational Dynamics	Ch. 10:3-4	
	27	Apr. 3	Angular Momentum	Ch. 10:5	PS 9 due
	28	Apr. 5	Conservation of Angular Momentum	Ch. 10:6	

11	29	Apr. 8	Rotational Motion Practice	Ch. 10	
	30	Apr. 10	Newton's Law of Gravity	Ch. 13:1,3	PS 10 due
	31	Apr. 12	Kepler's Laws	Ch. 13:4-5	
12	32	Apr. 15	Simple Harmonic Motion	Ch. 14:1-3	
	33	Apr. 17	Simple Pendulum	Ch. 14:4-5	PS 11 due
	34	Apr. 19	**Exam III**	**Chs. 9,10,13**	
13	35	Apr. 22	Damped Oscillator	Ch. 14:6-7	
	36	Apr. 24	Wave Motion	Ch. 15:1-3	PS 12 due
	37	Apr. 26	Wave Speed	Ch. 15:3-5	
14	38	Apr. 29	Superposition & Interference	Ch. 15:6	
	39	May 1	Standing Waves	Ch. 15:7-8	
	40	May 3	Beats & Doppler Effect	Ch. 16:7-8	PS 13 due

FINAL EXAM (comprehensive): date and time TBD by the Registrar