

PHYS 221 Physics for Scientists and Engineers I

4 semester hours and an optional 5th hour of recitation

Syllabus for Fall 2025

Instructor: W. Blake Laing, Ph.D (Professor, Engineering and Physics)

Office: Hickman Science Center 1111A (Physics library office suite)

Contact information: Use the Piazza Q&A forum, email laing@southern.edu, call during office hours (423) 236-2662

Department tutoring: Generally 7pm-9pm Sunday through Thursday, depending on tutor availability

Course description and materials

The calculus-based treatment of mechanics, heat, and sound. Applies toward the basic science requirement as a non-laboratory science if taken alone or as a laboratory science if taken with PHYS 223. MATH 191 Calculus I is a prerequisite. For students continuing to the second semester PHYS 222, it is strongly advised to take Calculus III this semester.

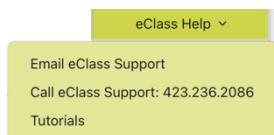
Textbook: Matter and Interactions, by Ruth Chabay, Bruce Sherwood, Aaron Titus, and Stephen Spicklemire

This course uses the campus Learning Management System which we call “eClass” :

<http://eclass.e.southern.edu>. For assistance with eClass, click on the Help tab at the top.

TL;DR (“too long; didn’t read” or “summary”)

- I drop one week of attendance and homework. No homework extensions unless for excused absence.
- This is a 4 hour class, so there are 4 classes/week. Plan on investing an additional 12+ hours per week.
- There are two classes Monday, so two assignments due Wednesday. That’s half of the assignments for the week! There is an optional recitation Tuesday at 11 for help with these two assignments.
- I’m your physics coach. There are no shortcuts to the program I’ve designed to prepare you for success.
- Homework is worth 5% by default, but if you opt-in to my academic integrity code then it is worth 30%.
- This is an in-person class: I will only “turn on Zoom” and/or record at my discretion and with 1 hour notice.



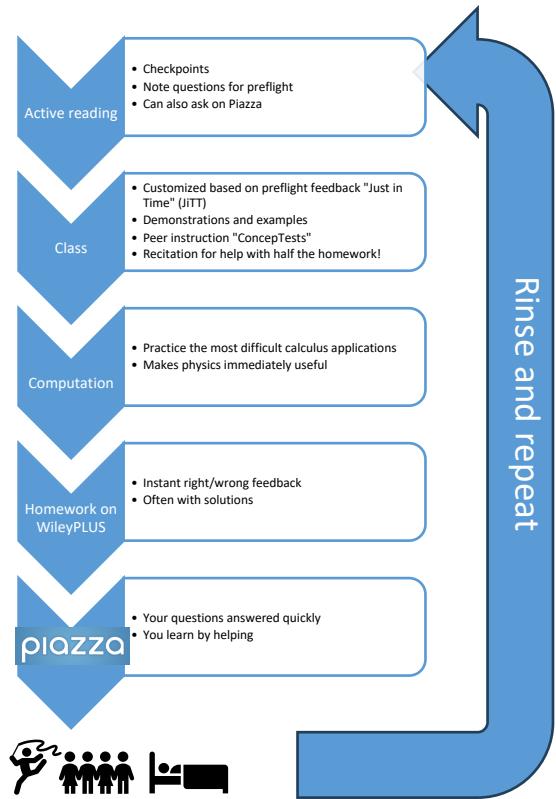
Class workflow

1. Read **before** class

Set aside at least 20 minutes to read. Note your questions and either ask them on Piazza to generate discussion or on the “pre-flight”.

2. Each class will be customized based on “pre-flight” feedback and questions submitted 1 hour before class. Come to class already familiar with the new basic information and ready to learn the hardest parts.
3. The optional recitation Tuesday 11:00 is not for credit but you’ll get help with the two assignments due Wednesday—that’s help with half the homework for the week!
4. Homework on WileyPLUS gives you limited feedback. I highly recommend that you **write out your solutions to homework in a single notebook**, but the answers will be submitted and graded online.
 - Due before the next day’s class with 5% penalty per day
 - No extensions given without excused absence.
5. Do you have questions on your homework? Ask a well-formed question on the Piazza.com Q&A forum, for quick help.

If you do the work of following this program, you will have already spent at least 30 hours preparing for the first test in a way that is endorsed by physics education researchers: no need to cram. It may be wise to spend another hour reviewing for the test, but you can rest in the confidence that you have already done most of the work that can be done.



Six section exams will consist of conceptual questions (short answer, multiple choice, or drawing diagrams) and homework-like problems. Bring a scientific calculator (or a graphing calculator). No phone calculators. I drop one lowest section exam score.

Learning incentives (AKA “how to get points”)

Grading scales

You are not competing with your classmates because you are not graded “on the curve”. I use a 5-point absolute grading scale so that each letter grade has equal statistical weight. I use this scale because research reveals that using the percentage scale in this calc-based physics course creates a bias which makes it numerically impossible to recover from low-F scores.



Letter	5-pt	%	Description
A+	5.0	100%	Correct
A-	4.0	90%	Basically correct understanding and approach
B-	3.0	80%	Notable conceptual or procedural mistakes
C-	2.0	70%	Right relationship, but unable to proceed
D-	1.0	60%	Correct and incorrect relationships, shopping
F	0.0	50%	Blank, irrelevant equations

Figure 1 Be skeptical of people who say “studies show” with no citation and beware of people who say “all the studies show”. Here is an excellent citation, and it is from a top journal ([link](#)).

A-	90-93	A	93-100		
B-	80-83	B	83-87	B+	87-90
C-	70-73	C	73-77	C+	77-80
D-	60-63	D	63-67	D+	67-70

Credit distribution: choose your own adventure

On-time attendance and participation is worth 10%. Physically coming to class but working on other things or distracting other people is not worth full credit.

By default, assignments (homework, quizzes, computations, etc) are worth 5% of the grade for students who are using their own integrity policy. Without judgement, I assume that by default students will copy from classmates, search for online solutions, use AI, or similar short-cuts that they feel help them learn. You can learn something from copying other people’s work, and that something is worth 5% in this class (tests worth 85%). If you decide to accept my academic integrity assignment policy, then assignments are worth 30% (tests only 60%).

Default Sign on to my integrity policy		
2%	2%	Preflights
8%	8%	On-time attendance and participation
5%	30%	Assignments
65%	45%	Six section tests (but drop one)
20%	15%	Final exam

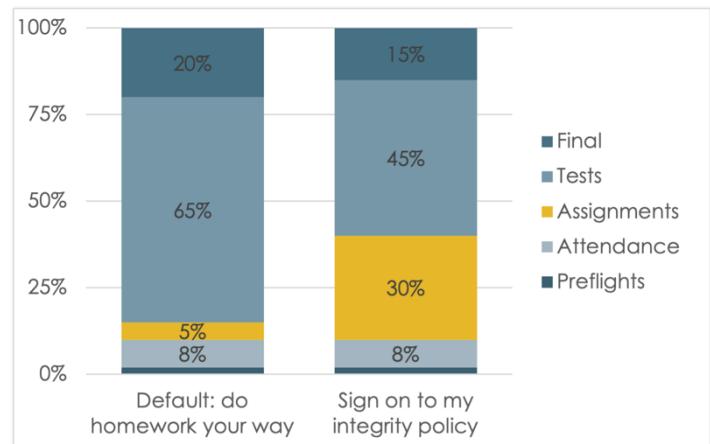


Figure 2 If you adopt my academic integrity policy, then homework and other assignments will be worth 30%. By default, assignments are worth 5%.

This is a four credit-hour class

Q. Can I just come to the three morning classes and skip the 4th session each week?

A. No, there are four classes per week for this four semester hour class. All four are just regular classes.

Q. Why does this class take so much time?

A. The guideline is to spend 2 hours outside of class per week for every credit hour. That means you should plan on spending an extra 3 hours per week (1 hour in class, 2 outside) than your 3 credit hour classes.

Learning objectives

1. Apply fundamental physical principles describing macroscopic quantities to new challenges
Clearly perceive the mechanics and thermodynamics principles relevant to a macroscopic quantities in a novel situation from the galactic to the subatomic scale (Sherwood, 2004).
 - 1.1. Describe motion using position, velocity, and acceleration vectors to describe motion, including using calculus.
$$\vec{v} = \frac{d\vec{r}}{dt} \Leftrightarrow \Delta\vec{r} = \vec{v}_{avg}\Delta t, \quad \vec{a} = \frac{d\vec{v}}{dt} \Leftrightarrow \Delta\vec{v} = \vec{a}_{avg}\Delta t$$
 - 1.2. Predict motion (or make deductions from observations of motion) using the “momentum principle” (Newton’s 1st, 2nd, and 3rd laws), including at relativistic velocities
$$\vec{F}_{net} = \frac{d\vec{p}}{dt} \Leftrightarrow \Delta\vec{p} = \vec{F}_{avg}\Delta t$$
 - 1.3. Describe rotational motion and predict rotational dynamics as well using the “angular momentum principle” (Newton’s laws for rotating systems).
 - 1.4. Employ the “energy principle” (the first and second laws of thermodynamics) to track all relevant forms of energy, including interaction energy and thermal energy.
 - 1.5. Include the system rest energy and changes thereof in the energy principle to apply the momentum and energy principles to collisions between high energy atoms and/or subatomic particles.
2. Apply microscopic/abstract physical models
 - 2.1. Use linear response models (e.g. the ball-and-spring model of solids, harmonic oscillator) to model properties such as the Young’s modulus and the speed of sound. Employ more precise non-linear response models of atomic interaction (such as anharmonic interatomic potentials).
 - 2.2. Identify which of the four fundamental physical forces (gravitational, electromagnetic, weak, and strong) are dominant at a particular scale. Understand reaction contact forces such as tension or normal force as emerging from electromagnetic interactions between atoms within these models.
 - 2.3. Employ the concept of vector field (gravitational, electric, and in the second semester magnetic field) and use the relationship between field, force, and potential energy.
 - 2.4. Extend any familiar classical model to become a semiclassical model by apply quantization of energy states, recognizing under which conditions it becomes necessary to do so.
 - 2.5. Use the fundamental assumption of statistical mechanics and quantitatively calculate thermodynamic variables such as entropy and temperature.
 - 2.6. Quantitatively describe wave phenomena such as interference, diffraction, and quantization.
3. Engage in modeling disciplines
Perform a meaningful analysis of a completely novel physical scenario by engaging in a process of model construction: making simplifying assumptions, making approximations, and estimating quantities (Sherwood, 2004).
 - 3.1. Use multiple representations to model a physical process: words, diagrams, mathematics, graphs, and code.
 - 3.2. Recast a calculation as a Maclaurin series expansion (Taylor series about zero) in a small parameter. Use this perturbative reasoning to quantitatively evaluate the accuracy of low-order approximations made in a model.
 - 3.3. Make reasonable estimations of unknown quantities and check that results are of a reasonable order of magnitude.
 - 3.4. Check that results have correct dimensionality/units and conform to expected behavior in extreme limits.
 - 3.5. Compute quantities such as center of mass, moment of inertia, net gravitational force vector field by numerically symbolically integrating over a continuous distribution of sources. Check for convergence of this Riemann sum integration.
 - 3.6. Represent physical quantities in a computer computation using appropriate VPython types (vector, float) and properties of objects (e.g. `sphere.pos`) and perform needed homework-like calculations in VPython.
 - 3.7. Use the “momentum update” form `p=p+Fnet*dt` of the momentum principle and the “position update” form `r=r+v*dt` of the definition of velocity to iteratively compute changes in momentum and position using Python. Evaluate the convergence of numerical integration in terms of the number of digits of precision.
 - 3.8. “Debug” common computation errors in both calculated quantities and in the behavior of iterative algorithms.

We write code to learn calculus-based physics

The most challenging calculus application in this course is the use of integration to solve a problem. In your calculus class, symbolic integration was defined as the limit of a Riemann sum:

$$\int_a^b f(x)dx = \lim_{N \rightarrow \infty} \sum_{i=1}^N f(x_i)\Delta x.$$

I believe that a significant reason that students have difficulty in using symbolic integration (on the left of the above equation) to solve engineering problems is that it's too abstract. That is why in class I more often will use the Riemann sum (at right) when setting up an integral: we code the right side of this equation to understand the left side.

We will use computation in this course to meet these three engineering learning objectives. None of these learning objectives is "learning how to code".

1. Understand the construction of an integrand in the most concrete form possible: using actual numbers.
2. Calculate a numerical integral to solve some engineering problems that would otherwise be impossible (using the Euler-Cromer method).
3. Check that the integration is "converged" to a limiting value to a requested precision.

I assume that students have zero programming experience (even though most have had Fundamentals of Programming), but I also assume that all students in this course will someday be expected to have the ability to at least interpret simple computer codes/scripts, likely including the Python language. Because of this, I make no apologies for also adding the following rudimentary computing skills that every engineer and scientist should get comfortable with.

1. How to perform engineering calculations and how to store results as a variable
2. That a computer evaluates a code one line at a time
3. Basic troubleshooting ("debugging")
4. Condition statements (if, then, else)
5. For loops and while loops
6. Using objects and properties for efficient coding (a first exposure to "object oriented programming")

Academic support

Take advantage of the unusual amount of support in this unusually challenging class!

1. Your reading questions should be answered before you leave class.
2. Ask a well-formed question on the Piazza.com Q&A forum, for quick help. Saying "I don't get number 2, can anyone help?" is not a question: it is a desperate plea. Do the work to pose a well-formed question to grow.
3. Homework on WileyPlus gives you basic feedback.
4. I choose my office hours for your convenience. Come talk to me, especially if you are discouraged.
5. Physics department tutoring is generally 7pm-9pm Sunday through Thursday.

There are also campus resources that you've already paid for

- Trouble with e-class? Email eclashelp@southern.edu or call 423-236-2086.
- Learning Support Services can help difficulties such as attention span, dealing with stress, etc.
- The Tutoring Center, located on the 3rd floor of McKee Library, provides free peer tutoring for more than 50 courses. Students can meet with a tutor to review principles, learn content-specific study strategies, and enhance content area knowledge. Schedule a 50-minute face-to-face appointment at <https://trac.e.southern.edu> or call the Center for assistance at 423.236.2578.
- The Student Success Team offers helpful resources to all students who strive to make the most of their college experience. This is accomplished through personalized, one-on-one meetings with a specially trained academic support manager. Topics include time management, taking notes, test taking tips, learning styles, etc. Schedule an appointment, email, call 423.236.2838 or visit the Student Success office in McKee Library, suite 2126.

Class policies are disciplines to support competency, efficiency, and integrity

Students of this course intend on career paths requiring great professionalism, and professionals are trusted with a lot of freedom in how and when they get their work done. My policies, due dates, and “end dates” are designed to require a minimal amount of necessary discipline while giving you as much freedom as reasonable.

- I drop 4 lowest assignment scores. For instance, you can skip the last 4 computations if you do all of your homework
- I drop 1 lowest section test score.

Q: Should I come to class while sick?

A: It's your call, but wear a mask if you come to class sick. You can just take a drop if you don't feel like calling the UHC (423.236.2713) for a medical excuse. You are still as fully supported on the Piazza Q&A forum and I can conduct office hours over zoom.

Q: Can you zoom or record class? Something came just came up.

A: If you have an excused absence, yes. Otherwise, probably not but feel free to provide more detail in your request.

Q: Can I get a homework extension? Can you cut me some slack if I tell you a story?

A: If you have an excused absence, yes.. Otherwise, I already cut you slack by dropping 4 assignments.

Students in the past have fallen so far behind that they couldn't catch up—it's better to let cut your losses and stay current on new homework. You already have two extensions: the end date and I drop 4 lowest assignment scores.

Dress for active learning

Plan to be active in class. Loose fitting or low-cut clothing that seem fine in the mirror may suddenly become awkward during class activities. We have a dress code which is part of the culture of this campus and plays a role in maintaining a quality learning environment.

Academic integrity leads to professional competence

When you arrive at your dream job, you will grow in your understanding of ethical expectations of your profession. Start now.

Students often follow a different code of ethics than the one their professor expects. For example, if Alice finds a copy of tomorrow's test that the professor stupidly left out, wouldn't it be unkind of her to not share information about the test that could keep her friend Bob from failing? Alice may feel good about her altruistic behavior to help Bob, but it is the professor who decides how Bob's grade is determined and therefore it is the professor, not the student, who defines what academic integrity is.

In general, any attempt to get points by circumventing the expected mode of participation in an activity or taking credit for the work of others will be considered a violation of academic integrity. The following some examples of violations of academic integrity in this course, whether or not you “sign on” to my agreement.

1. Taking a picture of a test for any reason or sharing a test in any way is theft. Viewing a stolen test is cheating.
2. Marking anyone's attendance as “present” when they are not present—attendance cheating will result in a zero for the category.
3. Marking yourself present instead of the time when you are late.
4. Posting your solutions to assignments (homework, computations, or quizzes, etc).
5. Posting homework solutions.

By default, you may use whatever resources you want to do assignments, because the assignment category is only worth 5%. If you choose to sign on to my academic integrity agreement for assignments by initialing and signing that agreement on the last page of this syllabus, then assignments will be worth 30%.

Q: What if a group of us get stuck for too long and we only look at online homework solutions?

A: Why didn't you ask a well-formed question on Piazza and move on, letting me or your classmates help you? No one should be stuck for too long. Or tell me that you are switching back to the default 5% homework option. Each of you should record a list of homework assignments for which you gave up on our agreement. Report to me in the last week.

Professional integrity (or fraudulent behavior) starts early, and to help students experience success (and avoid possibly career-altering mistakes), violations to our class academic integrity will be reported¹. Why? Because we want to help you embrace professional integrity to succeed in your calling. See Academic Honesty, SAU Catalog.

Artificial Intelligence (AI): will you be smarter than the tools that you use?

You're welcome to use AI to do your homework for you if you are using the default 5% credit, and I'll be interested to know how you are doing it. We actually have experimented with a homework platform that includes an AI tutor with a sensible way to award credit for real work but students didn't like it. If I introduce a computational assignment in this class to show you how to use AI, then you'll use it in the manner I ask. Artificial intelligence can be leveraged in more powerful ways by people who have fundamental knowledge and competency in their discipline, but people who use AI to get by without developing this knowledge *deserve to be replaced* by it.

SAU statement on AI use in the classroom.

The rise of generative AI as a powerful computing tool is likely to be a game changer across society ... but using AI may also short circuit the development of critical thinking and core professional knowledge. It may also rob us of the opportunity to develop the imaginative, creative and analytical capacities needed to thrive in our callings and communities in the future.

...

For these reasons, students are expected to use AI only after discussion with their instructors to verify that the use fits the goals of the assignment and the course. Inappropriate use may be penalized.

Physics for Scientists and Engineers II 2025

Or how to learn 300 years of physics in 56 classes

Mon 08/25	Describing motion, detecting interactions	1.1-1.3	Mon 10/20	Energy transfer, power	7.4-7.7
Mon 08/25	Describing the 3D world: Vectors	1.4	Mon 10/20	Computational models, ref. frames, resonance	7.8-7.10
Wed 08/27	Units, speed and velocity, updating velocity	1.5-1.7	Wed 10/22	Photons, electronic energy "levels"	8.1-8.2
Fri 08/29	Graphs, momentum, high velocity	1.8-1.10	Fri 10/24	Vibrational and other energy levels, lasers	8.3-8.7
Mon 09/01	Computational modeling: sparrow and hawk	1.11	Mon 10/27	Exam III: the energy principle (Ch 6-8)	
Mon 09/01	Force, impulse, and the momentum principle. $F=ma$	2.1-2.2, 2.10, 2.11	Mon 10/27	Center of mass, multiparticle energy terms	9.1-9.3, 9.6-9.7
Wed 09/03	Motion with a constant force, spring force	2.3-2.4	Wed 10/29	Point particle vs extended system, friction	9.4
Fri 09/05	Spring force, motion with a variable force	2.5-2.7	Thu 10/30	Last day to drop with a "W" grade	
Mon 09/08	Last day to add a different class		Fri 10/31	Gases and heat engines	\$1.1-\$1.4
Mon 09/08	Constant net force: computation and analysis	2.6	Mon 11/03	Energy transfers, efficiency	\$1.5-\$1.8
Mon 09/08	Impulse approximation, relativistic motion	2.8, 1.12, 1.13, 2.9	Mon 11/03	Irreversability, Einstein solid	12.1-12.2
Wed 09/10	Exam I: describing motion, momentum. Forces (Ch 1-2)		Wed 11/05	Thermal equilibrium, second law, temperature	12.3-12.5
Fri 09/12	Gravitation, reciprocity, g	3.1, 3.4-3.5	Fri 11/07	Specific heat of a solid	12.6
Mon 09/15	Orbital motion, iterative computation	3.2-3.3	Mon 11/10	Computation, Boltzmann distribution	12.7-12.9
Mon 09/15	Four fundamental forces, Conservation of momentum	3.6-3.8	Mon 11/10	Continued	0
Wed 09/17	Applications, limitations	3.9-3.10	Wed 11/12	Exam IV: energy principle (Ch 9, S1, 12)	
Fri 09/19	Linear response of materials	4.1-4.4	Fri 11/14	Rotational angular momentum, cross product	10.1-10.2
Mon 09/22	Applications: Young's modulus, friction	4.5-4.6	Mon 11/17	Computation, gyroscope	10.7, 10.10
Mon 09/22	Vibrations: iterative analysis	4.7, 4.11	Mon 11/17	Torque, angular momentum principle	10.3-10.4
Wed 09/24	Vibrating systems, speed of sound from bond stiffness	4.8-4.10, 4.14	Wed 11/19	Rotation + translation, tennis racket theorem	10.5-10.6, 10.11
Fri 09/26	Net force from change in momentum	5.1-5.3	Fri 11/21	Elastic collisions, Rutherford scattering	11.1-11.3, 11.8, 11.9
Mon 09/29	Circular motion	5.4-5.5	Mon 11/24		
Mon 09/29	Spring mass I	5.8	Mon 11/24		
Wed 10/01	Curving motion in general, sensations, components	5.6-5.7, 5.10	Wed 11/26	<i>Thanksgiving break</i>	
Fri 10/03	More complex curving motion problems	5.9	Fri 11/28		
Mon 10/06	Exam II: the momentum principle (Ch 3-5)		Mon 12/01	Inelastic collisions	11.4-11.5
Mon 10/06	Energy principle of a particle, work	6.1-6.2	Mon 12/01	Scattering physics	11.6-11.11
Wed 10/08	Energy principle, rest energy, potential energy	6.3-6.6	Wed 12/03	Wave phenomena	S3.1
Fri 10/10	Potential energy, plots, gradient and expansion	6.7, 6.8, 6.15	Fri 12/05	Mechanical waves	S3.4
Mon 10/13	Many particles, Comp (spring mass or space voyage)	6.9-6.12	Mon 12/08	Standing waves	S3.5
Mon 10/13	Energy and momentum principles, strategies	6.13-6.14	Mon 12/08	Wave vs particle, Fourier analysis, wave eq	S3.6-S3.9
Wed 10/15	Potential energy, internal energy	7.1-7.3	Wed 12/10	Exam V: Collisions and waves (Ch 10, 11, S3)	
Fri 10/17	Fall break		Fri 12/12	HW setup review	

Appendix

Philosophy and methodology

It's time to grow in your critical reading skills

PHYS 221 is your on-ramp to higher science and engineering classes. Students who memorize their way through this class will not be prepared to employ the higher-order reasoning skills expected of them later. To understand why memorizing homework recipes will not be enough, consider Bloom's Taxonomy below. My first job is to help you understand that coming to class having read the basic information in your textbook is the "seed", to which we will add higher-order learning: basic information is like a grain of sand to which we add layers to build a pearl of wisdom.

Knowledge is not transmitted by me—it is constructed by you. You can't passively absorb a robust comprehension of physics from perfect explanations. My job is to be an engineer of significant learning experiences for you using the latest "best practices". You'll need to come to class each day prepared to participate.

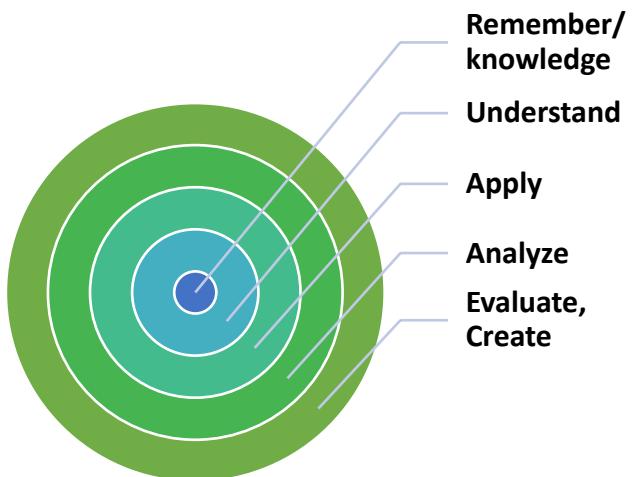


Figure 3 Bloom's taxonomy of educational objectives, in a unique hierarchical form relevant to learning physics. Remembering basic information is foundational, but the focus of this class is on the higher-order learning. While other introductory classes may emphasize memorizing, this is the least significant component of learning physics.

Let's move beyond "Equation shopping"

You'll hear many different perspectives on how to succeed in physics, as people journey toward an expert-like understanding of what it means to learn. You'll experience greater success if you understand from the beginning that the point of this class is not to plug numbers into equations. To underscore this point, equation sheets will be provided for the exams, such as this one which will be provided for the first exam. Students looking a "formula" will be disappointed.

$v_x \equiv \frac{dx}{dt}$ $a_x \equiv \frac{dv_x}{dt}$ $s_f - s_i = \int v_s dt$ $v_{fs} - v_{is} = \int a_s dt$	$\omega \equiv \frac{d\theta}{dt}$ $\alpha \equiv \frac{d\omega}{dt}$ $\theta_f - \theta_i = \int \omega_s dt$ $\omega_s - \omega_i = \int \alpha_s dt$	$s = r\theta$ $v_t = r\omega$ $a_t = r\alpha$ For circular motion $a_c = \frac{v^2}{r} = r\omega^2$
$v_{fs} = v_{is} + a_s \Delta t$ $s_f = s_i + v_{is} \Delta t + \frac{1}{2} a_s (\Delta t)^2$ $v_{fs}^2 = v_{is}^2 + 2a_s \Delta s$ <div data-bbox="169 882 486 998" style="border: 1px solid black; padding: 5px;"> <p>[On the tests] several times I found myself unable to answer questions because I forgot the formula and it wasn't provided</p> </div> 	$\omega_f = \omega_i + \alpha \Delta t$ $\theta_f = \theta_i + \omega_i \Delta t + \frac{1}{2} a_s (\Delta t)^2$ $\omega_f^2 = \omega_i^2 + 2\alpha \Delta \theta$ <div data-bbox="682 895 894 988" style="border: 1px solid black; padding: 5px;"> <p>I wish someone had told me: "this isn't a math class!"</p> </div> 	Constants $g = 9.81 \text{ m/s}^2$ Quadratic equation If $ax^2 + bx + c = 0$ then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ If $\frac{1}{2} a_s t^2 + v_{is} t = \Delta s$ then $t = \frac{-v_{is} \pm \sqrt{v_{is}^2 + 2a \Delta s}}{a}$ $t = -\frac{v_{is}}{a} \pm \sqrt{\left(\frac{v_{is}}{a}\right)^2 + \frac{2\Delta s}{a}}$



It will not do to memorize the formulas, and to say to yourself, "I know all the formulas; all I gotta do is figure out how to put 'em in the problem!"

Now, you may succeed with this for a while, and the more you work on memorizing the formulas, the longer you'll go on with this method - but it doesn't work in the end. You might say, "I'm not gonna believe him, because I've always been successful: that's the way I've always done it; I'm always gonna do it that way."

*Richard Feynman
1965 Nobel Laureate in Physics
Author of "The Feynman*

You are not always going to do it that way: you're going to fail - not this year, not next year, but eventually, when you get your job, or something - you're going to lose along the line somewhere, because [science] is an enormously extended thing: there are millions of formulas! It's impossible to remember all the formulas - it's impossible!

We are called to develop our gifts to understand and employ objective truth

A core Biblical concept relevant is that God has given you students both particular gifts as well as an investment of resources ("talents") according to those gifts. This means that you have been given agency on how to use these gifts and resources.

Our calculus-based introductory physics course PHYS 221 Phys. for Sci. & Eng. I is the first "real" physics course taken by department majors (Engineering, Biophysics, Physics) and may be the only science course taken by other majors. This course focuses explicitly on the development of relevant professional skills, such as using calculus thinking or computational modeling, as well as scientific epistemology (how knowledge is developed). Physics epistemology is very strongly rooted in the Biblical world view that there is such thing as objective truth, and that we should expect there to be order and beauty in creation. Contrary to popular belief, the theory of relativity actually starts with two postulates which assume that there is an objective truth, allowing observers to reconcile seemingly conflicting measurements. In stark contrast to presuppositions of postmodern thought, Albert Einstein framed his life's work as wanting to "know the mind of God".

"I want to know how God created this world. I'm not interested in this or that phenomenon, in the spectrum of this or that element. I want to know His thoughts, the rest are details"

Albert Einstein

You'll perform much better in this class if you study in order to understand the elegance and simplicity of physics. Our textbook emphasizes that these many equations are simply applications of a couple principles.

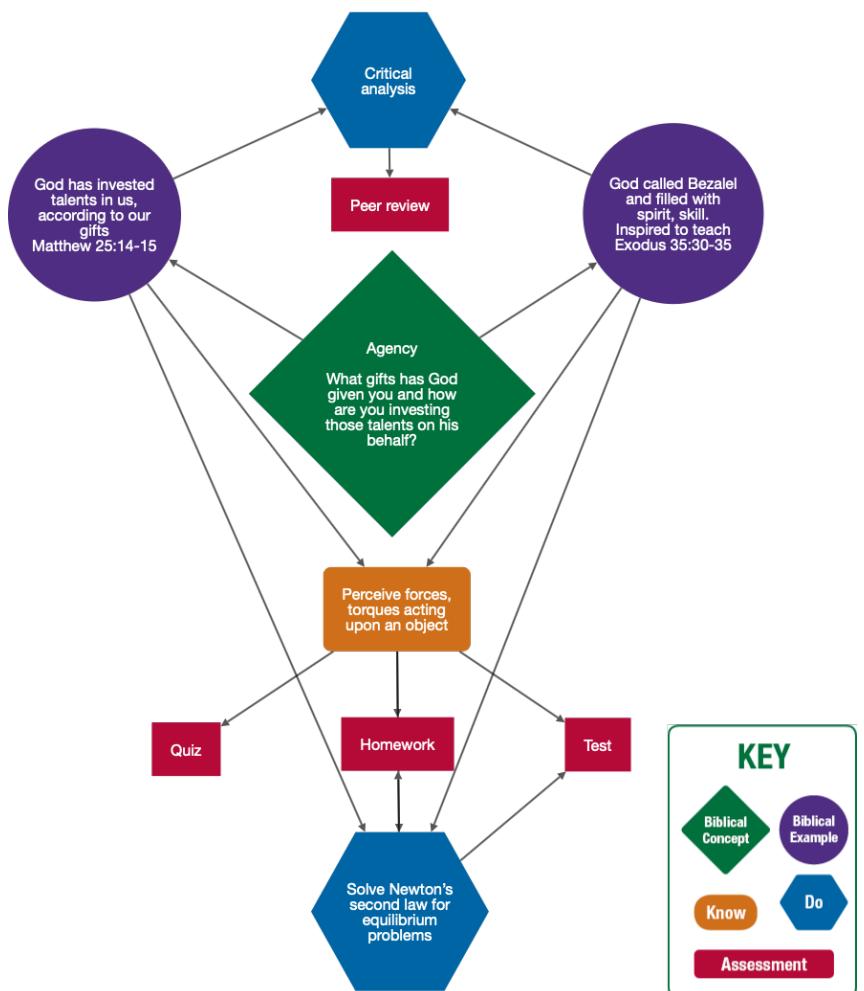


Figure 4 Biblical foundations model applied to PHYS 221 Physics for Sci. & Eng. I, by Blake Laing.

Do you want a better grade?

Q: Can you give me a higher letter grade?

*A: Let's talk about that **in person during office hours, not by email after the semester is over**. We'll compare your performance to the qualitative grading scale below.*

A: Mastery of core material: able to synthesize and evaluate

The student has demonstrated mastery (both in comprehension and in performance) appropriate to the level of this course.

B: Able to start complex problems and to solve single concept problems

The student has demonstrated sufficient comprehension and performance. I remain confident that this student is at least prepared for the next step.

- Can solve complex problems which combine multiple concepts, choosing the “right tools for the job” and strategically using them to solve the problem at hand.
- Equations are understood as physical relationships, not as magical formulas.
- Mistakes on exams are typically due to minor details or algebra
- Mastery of many, but not all, relationships is demonstrated.

C: Progressing from understanding single concepts to applying understanding to multi-concept problems

The student shows partial understanding, having still some areas for growth in comprehension and/or performance, but I believe that this student can “catch up” in future coursework with extra remedial effort.

- The student can solve most single concept needed simple problems putting two concepts together strategically, even if they make mistakes on the details.

Mastery of some, but not many, relationships is demonstrated. Some “equation shopping”: hunting for formulas with the right symbols rather than correctly identifying the relevant relationship and reasoning from first principles.

D: Knowledge of material, at the level of familiarity, but struggling to demonstrate understanding or application.

The student learned enough *about* physics to pass this course but has not demonstrated the ability to *use* physical ideas in future coursework. This is a “pause and prepare” signal, to help students experience success in the future.

- Mastery of few relationships is demonstrated.
- Mostly equation shopping, grasping for ready-made formulas rather than starting from first principles.
- “Plugging in” quantities in ways that does not make sense.
- Some will confuse fundamentally different things: length is speed, the value is the rate of change, etc.

The student may be able to recognize relevant relationships but needs to be able to “put the pieces together” to solve a complex problem.

F: The student may have homework points, but their exams look like too much like someone came in “off the street” and (given an equation sheet) took the exam without taking the class. A sufficient increase in understanding has not been demonstrated and I encourage you to come talk with me about what prevented you from learning this semester.

Durable skills

SAU has a vision for how our graduates will thrive in the workplace, because they will have developed “durable skills” in the sequence of their college courses. We have identified seven durable skills, and you can grow in each one of these in this course. This conversation on campus is only just beginning, and here are some ways that these durable skills can be developed in this course.

1. Effective communication
 - a. Ask a well-formed question and get a well-formed answer. “I don’t get number 3” isn’t a question, you can do better than that.
 - b. Discuss and debate physics homeworks with your classmates.
2. Leadership
 - a. Form study groups and guide the group back toward productivity
 - b. Let me know face-to-face or on Piazza when there is a problem that your class is experiencing
3. Creative Problem Solving
 - a. Homework
 - b. Tests
4. Adaptability/Flexibility
 - a. “The test was nothing like the homework!”
5. Time Management
 - a. Make time to read before class.
 - b. Make time to do homework when you can get help
 - c. Don’t waste time being stuck: ask a well-formed question and move on.
6. Teamwork/Collaboration:
 - a. nurture disciplined homework behavior.
7. Research

Two options to work with integrity

Based on student feedback, such as the quote at right, I am giving students the freedom to choose two paths.

1. By default you can do whatever you want in response to my assignments. You'll have my professional respect² because you aren't trying to steal undeserved credit by "beating the system" or not being true to your word. Assignments are only worth 5% of your grade and tests will be worth more of the grade.
2. I do recommend that you adopt my academic integrity agreement on this page: assignments will be worth 30% towards your course grade. Choosing this option can't possibly lower your grade (I'll give you the maximum of these two options).

"The instructor should be more open-minded toward student use of online homework solutions... since it is exams that truly evaluate a student's personal mastery of the material, the instructor (and his syllabus) should not be so condemning of these methods."



If you want to sign on to my academic integrity agreement, **you will come to my office hours in person the week before midterm grades are due to turn in this form to let me know whether you complied with this agreement at the 100%, 90% or other level.** Bring your homework notebook (or other evidence that you at least set up most of the problems)

Yes! I have signed on to Dr. Laing's academic integrity agreement, because I think it will help me learn the best.

1. To complete my homework, I have refused to take these short-cuts (initial each one)
 - a. I never shared my codes or used someone else's shared codes for my homework.
 - b. I didn't even peek at online solutions to my homework, like Chegg.com, Yahoo answers, etc. Those things wouldn't be wrong if I was on the default 5% plan but I chose to sign on to this plan instead.
 - c. I worked with classmates, but I didn't use their formulas and "plug in" my numbers. If something doesn't make sense, I seek out the help and resources I need to understand it instead of getting points for someone else's thinking.
 - d. I didn't use AI tools for homework points, although I'm free to use AI for anything that isn't scored.
 - e. If I do break this agreement for an assignment, I'll mark it on my schedule will let the professor know here how many assignments were completed with the integrity policy.
2. For coding assignments, I will never paste anyone's code for any reason, except for code from the instructor.
3. For quizzes, I will not look at anyone's solution until I have finished the quiz under test conditions. Only after I record my time will I feel free to work with my classmates and review solutions.
4. To complete my homework, I will feel free to use these resources
 - a. I'll learn from the examples in textbooks, to prepare to apply my knowledge to a completely new situation. This is the best way to study for a test with new questions that you haven't seen before.
 - b. I may ask AI to explain problems that I'm not getting points for anyway. I may look at solutions to homework problems that I'm not getting points for.
 - c. I will hopefully work with classmates as peers, but I will avoid any unhealthy dependencies.
 - d. I won't ever waste too much time being stuck without reaching out for help. I'll talk to classmates, post a real question to Piazza, come to office hours, or come to tutoring.
 - e. I'll use mathematical software such as VPython, MATLAB, Wolfram alpha and other tools to evaluate/check integrals and derivatives. This isn't Calculus II class and professionals use tools.

Print name: _____

Sign and date: _____

² When I took Differential Equations, I proposed to my professor to make my grade 100% test scores so that I wouldn't have to do homework. I signed a contract with him, and he still treats me with professional respect. It turned out to be an unwise decision: although I earned an A in that class I floundered in Differential Equations (receiving a B-).