

FUNDAMENTALS of PHYSICS III (“Modern Physics”) *

PHY-2030 SECTION 01, FALL 2018

LECTURE: TTh 0945–1125; LAB: T 0740–0940; 129 COUCH HALL

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Course Description: An introduction to space-time physics and quantum physics with applications in astronomy, cosmology, solid-state physics, nuclear physics, and particle physics. Four credits. Prerequisite: PHY 2020. Offered Fall Semester.

Course Website: physics.highpoint.edu/~bbarlow/courses/phy2030/phy2030.html

Attendance Policy: If you have more than two unexcused absences, you can be withdrawn from the class. I reserve the right to choose whether to withdraw you or not for lack of attendance.

Textbook: *Six Ideas that Shaped Physics* by Thomas Moore (required). We will use the 3rd edition of Unit R (Relativity) and Unit Q (Quantum). These are separate books published by McGraw Hill.

Expectations / Daily Schedule: Expect to work hard, to be challenged, to learn, and to work together. Unlearn what you have learned: many of the ideas we will discuss are not aligned with human intuition. Most days will begin with a reading quiz that covers the chapter content and exercises that you should have completed before coming to class. Reading quizzes and Two-Minute Problems are used for self-evaluation to assess how much you retained from reading the chapter. Daily preparation and participation is **absolutely required** for your success in the class, as well as the success of your classmates. Each class will be arranged according to the following schedule:

- Reading quiz and Two-Minute Problems
- Chapter review and discussion
- Activities and simulations
- Cooperative group problems
- Summary of big ideas

You are expected to do at least five hours of work outside of class each week, including reading, solving problems, and working on your class project.

Grade Policy: We are going to use a different approach to assessment this semester called “Standards-Based Grading” (SBG). Each chapter has a list of standards to be met that you can find on the course website, along with the “evidences” that must be provided for each standard. You will solve problems, write computer programs and do experiments to show your understanding (i.e. proficiency) on each standard. We will have periodic quizzes, exams, and collaborative problem solving sessions where you can demonstrate proficiency on each standard. You will also be given example problems that you can use to show your proficiency. At any time, you can re-assess *up to two standards per week* to demonstrate your proficiency. Your grade is not final until the end of the semester and you can use the entire semester to demonstrate your understanding. However, when being reassessed, it’s possible for your proficiency to *decrease* as well. Your current progress on standards will be accessible through a Google doc.

*I reserve the right to change this syllabus based on feedback from you and what I determine is best for the course.

Using SBG helps address several issues with ‘traditional’ assessment:

- Sometimes one focuses on points instead of learning.
- When one does poorly on an exam, there is no incentive to study the material that one did not understand. Additionally, one loses the points on that exam even if the material is understood by the end of the semester.
- When you get a grade on an exam, like 70%, it might mean that you understood 70% of the content and do not understand 30%. The overall score does not tell you which concepts/skills you are proficient at and which ones you still need to study or practice. By tying each question on an exam to a standard and grading each question (not the exam), you know exactly which standards you still need to study.
- Cramming for an exam is rewarded, not the habits that lead to life-long learning like persistence and independence.

You will be graded on a 4-pt scale for each standard. To convert each 4-pt standards rating to a percentage score, the following non-linear relationship will be used:

$$\text{Standards \% Score} = \left(\frac{\text{Standards Four Point Score}}{4} \right)^{0.7} \times 100 \quad (1)$$

For example, if you receive a rating of “3” on the standard “MQ,” that is equivalent to a percentage score of 81.7% for that standard. The rubric for the 4-pt scale is shown below and is borrowed from Aaron Titus and Andy Rundquist (who cites Frank Noschese).

Four-Point Scale:

0. **Not assessed:** 0 pts

1. **Doesn’t meet expectations:** 1 pt

- (a) I need lots of help from my instructor (one-on-one).
- (b) I have low confidence on how to do the skills and need more instruction.
- (c) I need my textbook/notes at all times.
- (d) I do not understand the concept/skills.
- (e) I cannot correctly identify concepts and/or define vocabulary.
- (f) I cannot make connections among ideas or extend the information.
- (g) My responses lack detail necessary to demonstrate basic understanding.
- (h) Cannot articulate most of the main ideas involved in the standard

2. **Approaches expectations:** 2 pts

- (a) I have a general understanding of the content/skills, but I’m also confused about some important parts.
- (b) I need some help from my instructor (one-on-one or small group) to do the skills correctly
- (c) I do not feel confident enough to do the skills on my own
- (d) I need my textbook/notes most of the time.
- (e) I can correctly identify concepts and/or define vocabulary; however I cannot make connections among ideas and/or independently extend my own learning.
- (f) My responses demonstrate basic understanding of some main ideas, but significant information is missing.

3. **Meets expectations:** 3 pts

- (a) I understand the important things about the content/skills.
- (b) I have confidence on how to do the skills on my own most of the time, but I need to continue practicing some parts that still give me problems.
- (c) I need my handouts and notes once in a while.
- (d) I am proficient at describing terms and independently connecting them with concepts.
- (e) I understand not just the “what,” but can correctly explain the “how” and “why” of scientific processes.
- (f) My responses demonstrate in-depth understanding of main ideas.

4. **Exceeds expectations:** 4 pts

- (a) I understand the content/skills completely and can explain them in detail.
- (b) I can explain/teach the skills to another student.
- (c) I have high confidence on how to do the skills.
- (d) I can have a conversation about the skills.
- (e) I can independently demonstrate extensions of my knowledge.
- (f) I can create analogies and/or find connections between different areas within the sciences or between science and other areas of study.
- (g) My responses demonstrate in-depth understanding of main ideas and of related details.

Assessments: There will be at least three 100-minute long assessments (exams). They will typically consist of two or three of the following sections: (1) conceptual and numerical multiple choice questions; (2) problem solving; (3) computational modeling. All assessments, including the final exam, are comprehensive and can include any standards that are “live” up to that point in the semester.

Colloquium Attendance: The Department of Physics will host colloquia talks on **Sept. 7th, Oct. 5th,** and **Nov. 2nd**, from 12:00-1:00pm in 138 Couch Hall. Students in intermediate and advanced physics courses must attend all talks for credit in their courses.

Project: You will do a class project that is experimental, computational, or theoretical in nature. The project must be approved by Dr. Barlow. It must be related to topics in the course. There are five categories that the project’s grade is based on.

1. level of difficulty
2. level of creativity
3. level of independence
4. completeness (i.e. Does the simulation run and give correct results? or Did you report uncertainties in your measurements? or Did you include relevant background material and references)
5. quality of presentation and/or paper.

Different projects will have different requirements for what must be submitted upon their completion. These requirements are to be discussed with Dr. Barlow ahead of time. However, *all student must present their project to the entire class at the end of the semester.*

Grade Breakdown:

Proficiency with Standards ^a	80%
Project	10%
Participation	7%
Colloquium Attendance	3%

^aincluding lab standards assessed by Dr. Lancaster

Letter grades will be assigned based off of the following scale:

≥ 97	A+
93.0 - 96.99	A
90 - 92.99	A-
87 - 89.99	B+
83 - 86.99	B
80 - 82.99	B-
77 - 79.99	C+
72 - 76.99	C
70 - 71.99	C-
60 - 69.99	D
< 60	F

Extra Credit: No extra credit is currently planned; however, the instructor reserves the right to provide extra-credit assignments to the entire class when deemed necessary. *If* such an opportunity is provided, details will be announced during the lectures.

Honor Code: The High Point University Honor Code asserts that:

- Every student is honor-bound to refrain from conduct which is unbecoming of a High Point University student and which brings discredit to the student and/or to the University;
- Every student is honor-bound to refrain from collusion;
- Every student is honor-bound to refrain from plagiarism;
- Every student is honor-bound to confront a violation of the University Honor Code;
- Every student is encouraged to report a violation of the University Honor Code.

My obligation is to promote academic integrity and to enforce the University Honor Code. This obligation includes appropriately interpreting the Honor Code, promoting conditions favorable to academic integrity, and reporting violations of the Honor Code.

I encourage collaboration on homework. I encourage you to work together to solve problems. You may check your work with others. You may use solutions manuals, tutors, books, and any other resource on homework. However, you must know how to solve problems independently so that you can solve unfamiliar problems on exams.

You must do your own work on an exam. You may not look at another persons exam. You may not use any other resource except the equation sheet that is given to you and your calculator. You may not store programs or equations in your calculator, and you may not use data stored in your calculator on an exam. Calculators may only be used to input numerical values and perform calculations.

Violation of the honor code will be handled according to procedures outlined in the Faculty Handbook.

Diversity & Inclusivity Statement: High Point University is committed to fostering an inclusive learning and living environment. We welcome and respect all students, faculty, and staff of all races, ethnicities, religions, genders, sexual orientations, sexual identities and gender expressions, abilities, classes, ages, and political ideas. Diversity in identity, thought, belief and perspective enrich the academic experience and is critical to your growth as a lifelong learner. It is our expectation that every member of our university community uphold a standard of civility and respect both inside and outside of the classroom. HPU Multicultural Affairs (Slane 319) is a campus resource available to anyone seeking support or with questions about diversity and inclusion at High Point University. If you experience or witness an act of bias at HPU or would like to learn more about our Bias Reporting Process, please email diversity@highpoint.edu.

Accommodations: Students who require classroom accommodations due to a diagnosed disability must submit the appropriate documentation to the Office of Accessibility Resources and Services (OARS), 4th Floor Smith Library. Requests for accommodations should be made at the beginning of a course. Accommodations are not retroactive. Contact us at <http://www.highpoint.edu/oars/contacts/>, or call Ms. Dana Bright, Director of OARS, at 336-841-9361, for additional information.

Table 2: Standards

Chapter	Name	Standard
	LApp	I can use a lab apparatus with appropriate technique to make measurements accurately and precisely.
	LData	I can properly obtain, reduce, and analyze data, and I can calculate and use the uncertainties associated with measurements to remark on the validity of my results.
	LNote	I can keep and maintain a laboratory notebook using appropriate record keeping techniques in science.
	LRForm	I can write a lab report in LaTeX following the structure and guidelines presented to me by my lab instructor.
	LRClarity	I can write clear and concise text in a lab report that describes an experiment, measurements, and conclusions.
	LRData	I can use tables, plots, and other figures in a lab report to present data and results in a clear, effective, and aesthetically pleasing way.
	LFermi	I can solve mathematical problems (e.g., “Fermi” problems) in my head and on paper without the use of a calculator (to within an order of magnitude of the correct answer).
R1	Rel	I can state the Principle of Relativity and can apply it to non-relativistic motion
R1, R2	SR	I can provide evidence for Special Relativity and can apply SR to relativistic motion
R2, R3, R4	Time	I can measure or calculate position, coordinate time, proper time, and spacetime interval, and I know what quantities are invariant.
R5	LT	I can calculate (and compare) spacetime coordinates of an event for observers in different inertial frames.
R6	LC	I can calculate (and compare) length measurements for observers in different inertial frames.
R7	V	I can calculate (and compare) velocity measurements for observers in different inertial frames.
R7	Causality	I can determine whether two events are causally related.
R8, R9	4Mom	I can calculate mass, momentum, energy, and 4-momentum for a particle, and I know which quantities are invariant and which quantities are conserved.
R9	Cons	I can apply conservation of 4-momentum to a system.
Q1, Q2	WS	I can describe the modes of a standing wave (whether transverse or longitudinal) whether it is fixed at both ends or free and fixed at each end.
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Table 2 – continued from previous page

Chapter	Name	Standard
Q3	WI	I can use path difference to predict the interference of two sources of waves at a location.
Q4, Q5	WP	I can provide evidence for wave-particle duality and can apply a particle model or a wave model to a quanton, depending on the experiment.
QA	MQ	I can use the mathematics needed to describe the state of a quanton, including complex algebra, the inner product of two complex vectors, probability, and normalization.
Q6, Q7, Q9	Qrules	I can recite and apply the "rules of the game" of quantum mechanics.
Q10, Q11	Qenergy	I can derive energy eigenvalues for various systems and can relate energy eigenvalues to a spectrum of photons emitted or absorbed.
Q12	TISEDer	I can derive the time-independent Schroedinger Equation (TISE)
–	TISE	I can demonstrate that a given wavefunction is consistent with the TISE, and I can solve the TISE for very simple potential functions.
Q12	Qpsi	I can sketch qualitatively accurate wavefunctions in the presence of various given potential functions.
Q13, Q14	Nuclei	I can use simple principles to estimate the sizes of nuclei and calculate their binding energies.
Q14	Decay	I can describe the main types of radioactive decay and calculate decay rates.
H1	DM	I can derive equations for the masses of simple galaxies and justify the existence of dark matter using observations from the literature.
H2	GR	I can state the the Principle of Equivalence and use it to make predictions concerning the behavior of light and other objects in gravitational wells.
H3	COS	I can derive simple cosmological models describing the structure and evolution of the universe.
H4	DE	I can use arguments from first principles and observations in the literature to justify the existence of dark energy.