1.7 Typical course schedule

First year (Fall)

Mathematical Methods of Physics	3 credits
Classical Mechanics	3 credits
Quantum Mechanics I	3 credits
Introductory research area course *(optional)*	0–3 credits
Colloquium	0 credits
	9–13 credits

First year (Spring)

Electrodynamics	3 credits
Quantum Mechanics II	3 credits
Statistical Thermodynamics	3 credits
Introductory research area course *(optional)*	0–3 credits
Colloquium	0 credits
Seminar	2 credits
Research and Dissertation	1 credit
	12–15 credits

Second year and beyond

Research area courses *(optional)*	0–9 credits
Scientific Writing for Physicists *(optional)*	0–1 credits
Physics Teaching Practicum *(optional)*	0–1 credits
Colloquium	0 credits
Seminar	2 credits
Research and Dissertation	1-9 credits
	9–15 credits

1.8 Review of Physics summer course

The Review of Physics summer course sequence is intended for incoming graduate students before their first semester at Notre Dame:

PHYS 67001 Review of Physics A: Mechanics & Thermodynamics
PHYS 67002 Review of Physics B: Electromagnetism
PHYS 67003 Review of Physics C: Quantum Mechanics

Participation is optional, but highly recommended. This "physics boot camp" for incoming graduate students is an opportunity for you to review the essential components of your upper-level undergraduate physics courses, including classical mechanics (with some thermodynamics), electromagnetism, and quantum mechanics. The goal is to ensure that you and your colleagues have a common conceptual core, mathematical foundation, and problem-solving proficiency as you embark on graduate studies.

It is important to realize that this is a "forward looking" review, designed to ease you into the mindset of your core graduate courses and allow you to hit the ground running in the fall. For instance, electromagnetism will focus on the application of Maxwell's equations and wave dynamics, while quantum mechanics will focus on properly understanding quantum mechanics

in terms of state vectors and operators living in Hilbert spaces. We have chosen textbooks at an appropriate level to help you bridge this gap, and then, hopefully, to later serve you as resources in understanding the classic but notoriously dense graduate texts.

A significant emphasis will be placed on ensuring you are fully at ease with the necessary (but, as experience has shown, often spotty) mathematical background, such as vector analysis and linear algebra. There will also be an emphasis on critical problem solving approaches, or how to decide which approach to use and when to switch approaches, in order to help you with the transition from the simpler undergraduate-level problems you may be familiar with to the more challenging, open-ended problems you will find in your graduate courses.

The Preliminary Examination consists of three parts, split over three days, on Mechanics & Thermodynamics, Electromagnetism, and Quantum Mechanics. Each review course attempts to at least touch on the major topics from the corresponding part of the Preliminary Examination (Section 4). If you have mastered the basic concepts and proficiencies of undergraduate mechanics, thermodynamics, electromagnetism, and quantum mechanics, at the level reviewed in the summer course, the general expectation is that you should be able to pass the Preliminary Examination on your first attempt.

However, it is important to realize that it is *your responsibility* ensure that you have mastered the materials specified in the description of the Preliminary Examination (see Section 4), regardless of which specific topics might be selected for emphasis by the instructor when you take the review course. In the short time available, the review course can only *attempt* to review some substantial portion of undergraduate-level physics. It is up to you to study any materials which the review course might not have touched upon as deeply as you find you need (the specific areas in need of deeper review may be expected to differ from student to student depending on background). A variety of relevant textbooks, including the reference textbooks cited in the Preliminary Examination description, will be available on reserve in the Chemistry Physics Library.

Topics

Review of Physics A: Mechanics & Thermodynamics.

Statics (vector decomposition), central forces, rigid body motion, oscillatory motion and normal modes

Basics of Lagrangian/Hamiltonian formulation of classical mechanics

Laws of thermodynamics, ideal gas, state equation

Mathematical concepts reviewed include: Vector techniques and curvilinear coordinate systems; derivatives, chain rule, integration by parts; total differentials, directional derivatives, partial derivatives; basic ODE techniques (including exponential ansatz); Maxwell relations; *approaches for critically deciding among problem solving techniques and when to switch among them*

Review of Physics B: Electromagnetism.

Basic electrostatics from the perspective of the Laplace/Poisson equation (*e.g.*, Laplace/Poisson equation in simple geometries, image charges), multipole expansion,

magnetostatics

Maxwell's equations, electromagnetic waves, physical optics

Mathematical concepts reviewed include: Vector calculus for electromagnetism (gradient, curl, Laplacian, vector derivative identities, vector integrals); basic linear PDEs (separation of variables, exponential ansatz $e^{i\vec{k}\cdot\vec{r}}$ & $e^{i\omega t}$)

Review of Physics C: Quantum Mechanics.

General formalism of quantum mechanics in terms of linear operators and Hilbert spaces, matrix representation of quantum problems, coordinate/momentum representations

Quantum harmonic oscillator (Dirac formulation), basic properties of angular momentum operators, central force problem, identical particles

Mathematical concepts reviewed include: Linear algebra (matrices, vector spaces, eigenproblems); eigenbases (including Fourier transform & series); linear operators (their representations in various bases, commutator relations)