

Modern Physics with Laboratory

PHYS 302/304 • Spring 2026

Centenary College of Louisiana

Instructor	Dr. David Kordahl	Email	dkordahl@centenary.edu
Office	Centenary Square 203B	Lecture	MW 9:30–10:45 am, Mickle Hall 110
Office Hours	M 1:00–3:00 pm T 11:00 am–2:00 pm W 12:00–2:00 pm	Lab	F 1:00–4:00 pm, Centenary Square 208

Course at a Glance

Lecture Course	PHYS 302: Modern Physics
Laboratory Course	PHYS 304: Modern Physics Laboratory
Lecture Text	Kenneth S. Krane, <i>Modern Physics</i> , 4th ed., Wiley, 2019
Prerequisite	PHYS 105/115, Physics II and Physics II Laboratory
Corequisites	PHYS 302 and PHYS 304 are designed to be taken together

Course Description

Modern Physics introduces many of the key ideas that have guided research in the physical sciences in the twentieth and twenty-first centuries. The course begins with the twin revolutions of relativity and quantum mechanics, then follows their consequences into atomic physics, nuclear physics, statistical physics, condensed matter physics, particle physics, and cosmology. The goal is not only to learn a list of modern discoveries, but to understand how these discoveries changed the basic concepts of space, time, light, matter, and measurement.

The accompanying laboratory is closely aligned with the lecture course. Students investigate the experimental foundations of modern physics through activities involving electron charge-to-mass measurements, interference and diffraction, the speed of light, the photoelectric effect, electron diffraction, atomic spectra, polarization, and magnetic torque. The laboratory emphasizes the connection between theoretical models and experimental evidence, with particular attention to data analysis, uncertainty, and scientific communication.

Together, the lecture and lab ask students to see modern physics as both a conceptual revolution and an experimental enterprise.

Learning Goals

By the end of PHYS 302/304, students should be able to:

- describe how relativity changed classical ideas about space, time, simultaneity, and energy;
- explain how blackbody radiation, the photoelectric effect, and Compton scattering motivated the quantum theory of light;
- describe wave-particle duality for light and matter;

- use the Schrödinger equation to analyze simple quantum systems and interpret the meaning of wave functions;
- explain how quantum mechanics accounts for atomic spectra, electron spin, and the structure of the periodic table;
- describe the basic quantum ideas underlying molecules, solids, and statistical behavior of particles;
- explain the physical ideas behind radioactivity, nuclear processes, particle physics, and cosmology at an introductory level;
- collect and analyze experimental data from modern physics experiments;
- compare experimental results with theoretical models, including quantitative estimates of uncertainty;
- communicate modern physics ideas through written reports, laboratory analysis, and a final project.

Relationship Between Lecture and Lab

The lecture course develops the theoretical and conceptual framework of modern physics: relativity, quantum phenomena, wave mechanics, atomic structure, nuclear physics, statistical physics, and selected applications to matter and the universe. The laboratory course gives students direct experience with experiments that helped establish or illustrate these ideas.

Because the laboratory apparatus is limited, different groups may complete different experiments in some weeks. The overall sequence is designed to mirror the lecture course as closely as possible, while also giving students time to complete lab reports and work on the larger final project for Modern Physics.

Assessment

PHYS 302: Modern Physics

The lecture grade emphasizes homework, examinations, and a final project. The final project may take the form of a research poster for the Centenary Research Conference or a written paper of approximately 6–10 double-spaced pages.

Component	Weight
Tests	60%
Homework	25%
Final Project	15%

PHYS 304: Modern Physics Laboratory

Each laboratory activity has one graded assignment. Some activities conclude with a lab report, while others conclude with a completed lab packet involving questions and data analysis. Each lab is worth 25 points and is weighted equally.

Letter Grades

Grade	Percentage Range
A	90–100%
B	80–89%
C	70–79%
D	60–69%
F	below 60%

Detailed Lecture Schedule

This schedule records the specific lecture topics and approximate textbook coverage. The pacing may be adjusted as needed, but the table reflects the intended structure of the course.

Dates	Reading (Krane)	Lecture Topics
Jan. 12, 14	Ch. 1	Review of classical physics
Jan. 21, 26, 28	Ch. 2	Special theory of relativity
Feb. 2, 4	Ch. 3	Quantum properties of light
Feb. 9	Review	Review 1; final report topic due
Feb. 11	Test 1	Test 1
Feb. 23, 25	Ch. 4	Wave properties of matter
Mar. 2, 4	Ch. 6	Early atomic models
Mar. 9, 11	Ch. 5	The Schrödinger equation
Mar. 16	Review	Review 2; final report draft abstract due
Mar. 18	Test 2	Test 2
Mar. 23, 25, 30	Ch. 7	Wave model of hydrogen
Apr. 1, 8	Ch. 8	Multi-electron atoms
Apr. 13, 15	Ch. 10	Statistical physics
Apr. 20	Review	Review 3; final report due
Apr. 22	Test 3	Test 3
Apr. 27, 29	Review	Semester review
May 5	Final Exam	Final exam, 8:00–11:00 am

Detailed Laboratory Schedule

The laboratory sequence closely mirrors the lecture sequence in PHYS 302. Each activity is designed to reinforce concepts introduced in the lecture course while developing experimental, analytical, and scientific-writing skills.

Experiment	Date(s)	Guiding Question
Charge-to-mass ratio of the electron	Jan. 16	How can e/m be determined for an electron, treated as a classical particle, using a Helmholtz coil?
Light interference	Jan. 23	How accurately do single- and double-slit diffraction equations capture patterns from experiment?
Speed of light	Jan. 30–Feb. 6	Using a method based on that of Fizeau, how accurately can we determine the speed of light?
Photoelectric effect	Jan. 30–Feb. 6	Using a method based on that of Millikan, how accurately can we determine Planck's constant?
Electron diffraction	Feb. 13	How can scattered electrons exhibit the same wavelike behavior as observed in light?
Hydrogen spectrum	Feb. 27	How accurately does Bohr's formula capture the wavelengths of emitted light in the Balmer series?
Light polarization	Mar. 6–13	How can projection and intensity rules allow us to model polarized light and polarizing filters?
Magnetic torque	Mar. 6–13	How can spin precession be modeled macroscopically by a magnetic cue ball in a magnetic field?

Final Project Suggestions

Students may choose a final project topic in consultation with the instructor. Possible topics include:

1. Nuclear decay: experiment and theory
2. Franck-Hertz demonstration: experiment and theory
3. Blackbody radiation: experiment and theory
4. Brownian motion: experiment and theory
5. X-ray diffraction from crystalline samples: experiment
6. Beer's law and absorption spectroscopy: experiment
7. Electromagnetic basis of length contraction and time dilation: theory
8. Setup and demonstration of a cloud chamber: experiment
9. Demonstration of microwave diffraction or refraction: experiment
10. Cosmology simulation: theory
11. Nuclear magnetic resonance: experiment and theory
12. Modern physics in medicine: written review

Course Policies

Academic Honesty and the Honor Code

Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation. All students at Centenary are bound by the Honor Code. It is not considered cheating in this course to share suggestions on assignments with peers, although the final work must ultimately be one's own. Examinations, quizzes, and individual assignments are expected to be completed according to the instructions given for that assignment.

Students are required to write the following pledge at the end of any examination or assignment:

I have neither given nor received unauthorized aid on this examination (paper), nor have I seen anyone else do so.

If any student has received aid or suspects others of violating the Honor Code, the following clause is to be added to the pledge: "...except as I shall report immediately to the Honor Court." The complete pledge must be written and signed by the student, shall not be abbreviated, and should never be written until the test or paper has been completed for submission. Students are bound by the Honor Code even if they fail to write the pledge on their assignment or examination.

Attendance

Attendance is required. However, students are expected not to jeopardize their own health or anyone else's health to attend class. Illness-related absences will be excused. There is no penalty for missing class if students proactively communicate with the professor and complete all required work. If a qualified professional deems remaining in classes and fulfilling the necessary requirements impossible, alternatives will be sought in coordination with Student Support Services.

For PHYS 302, more than six unexcused absences will lead to a failing grade in the course. For PHYS 304, more than three unexcused absences will lead to a failing grade in the course.

Disability Accommodations

It is the policy of Centenary College to accommodate students with disabilities, pursuant to federal law, state law, and the College's commitment to equal educational opportunities. Any student with a disability who needs accommodations should inform the instructor at the beginning of the course. Students with disabilities need to contact Disability Services, a division of the Center for Teaching and Learning, located in the Learning Commons on the second floor of Magale Library. Disability Services can be reached by telephone at 318-869-5738 or by email at disability@centenary.edu.

Diversity Statement

Centenary College of Louisiana values human diversity in all its richly complex and multi-faceted forms, whether expressed through race and ethnicity, culture, political and social views, religious and spiritual beliefs, language and geographic characteristics, gender, gender identities and sexual orientations, learning and physical abilities, age, and social or economic classes.