PHYS2004A / PHYS2605A (Winter 2026)

Modern Physics for Engineers / Modern Physics I

Course Instructor: Prof. Manuella Vincter

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Office Location: Room 2458, Herzberg Building

Note: If you have a question or would like to talk with me, you can send me an email or come during a Student Hour. **All email communications must be done from your Carleton University account.**

Student Hours: see Brightspace for details

Class Location: Please check Carleton Central for the room location.
Class Times: Wed&Fri 16:05-17:25

Prerequisites: PHYS2004: PHYS 1002 or PHYS 1004 or PHYS 1008 with a grade of B- or better, plus MATH 1004 and MATH 1104 or equivalent. Restricted to B.Eng. students not in the Engineering Physics program. Students in programs other than B.Eng. must obtain permission of the Department. **PHYS2605:** PHYS 1001 and PHYS 1002, or PHYS 1003 and PHYS 1004 (PHYS 1007 and PHYS 1008 are also acceptable provided a minimum average grade of B- is presented); plus MATH 1004 and MATH 1104, or MATH 2052 and MATH 2152.

Preclusions: PHYS2004: Precludes additional credit for PHYS 2604 and PHYS 2605. **PHYS2605:** Precludes additional credit for PHYS 2004 and PHYS 2604.

Department/Unit: Physics

Calendar description

PHYS2004: Introduction to aspects of modern physics relevant to engineering. Thermal radiation. Concepts of relativistic kinematics. Wave-particle duality. Photoelectric effect, Compton scattering. Bohr theory of the hydrogen atom. Optical and x-ray spectra, lasers. Nuclear physics and applications. **PHYS2605:** The course is designed to provide a logical transition from classical to modern physics. Special relativity. Rutherford scattering, atomic models. Thermal radiation. Photoelectric effect, Compton scattering. Bohr theory of the hydrogen atom. Atomic energy states, optical spectra, lasers. X-rays. Radioactivity.

The prof reserves the right to make changes to this course outline. Any changes will be announced in Brightspace.

Welcome to PHYS2004/2605! I am delighted to be your prof this semester. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback. Please feel free to contact me via email or in person to let me know about any experiences you have had related to this class that have made you feel uncomfortable.

Land Acknowledgement: We, the people of the Faculty of Science at Carleton University, acknowledge that our campus is located on the traditional, unceded territories of the Algonquin Anishinabeg people. Miigwetch for your hospitality and stewardship of this territory and the teachings that come from it. We are grateful for this land, the air that we breathe, and the water that sustains us all as well as for the animals, plants and other living beings: these enable us to research, teach, mentor, support, study, and learn. We recognize our responsibility to our natural environment and to reconciliation with Indigenous peoples.

Version 1.0 dated Dec 17, 2025

Learning Material

Learning Material	Options for Purchase	Approximate Cost
Modern Physics for Scientists and Engineers, 5th ed, Stephen T. Thornton, Andrew Rex, Carol Hood. Cengage. ISBN: 978-1-337-91945-6	Textbook from www.cengage.ca or Carleton Bookstore	Cengage offers e-book access for $77.95 Carleton Bookstore offers e-book access for $79.95.

Topics Covered and Learning Outcomes

The course content is defined by the material **as covered in the lectures.** The course is based on material in Chapters 2-5, 7, 9, 12, 15 of the textbook. Not all the material in these chapters will be covered. A certain amount of material not contained in this textbook will also be included in the lectures. Class notes will be posted in Brightspace.

Topics to be Covered (Timing as given is prof's aspiration. Subject to change.)

Lecture #	Approx. date	Chapt	Part	Title	Some highlights of the topics
1, 2, 3	Jan 7, 9, 14	2	A	Relativity I	Classical relativity, Fizeau, Michelson-Morley, simultaneity, space-time Lorentz transformations, time dilation, length contraction, Doppler effect, twin paradox
4, 5	Jan 16, 21	2, 15	B	Relativity II	Relativistic momentum and energy, energy-momentum Lorentz transformations, energy-momentum relation, conservation vs. invariance, pair production and annihilation, binding energy, general relativity
6, 7, 8, 9, 10, 11	Jan 23, 28, 30, Feb 4, 6, 11	3	C	Quantization of Electric Charge, Light, Energy	The atomic view of matter, Thomson experiment, Millikan oil drop experiment, positive rays, mass spectrometer, Planck's law, blackbody radiation, Photoelectric effect, x-rays, radiation damage, Compton effect
12, 13, 15, 16	Feb 13, 25, Mar 4, 6	4, 7.3-7.5	D	Nuclear Atom	Rydberg-Ritz, Rutherford scattering, Bohr model, quantum numbers, Pauli exclusion principle, x-ray spectra, Franck-Hertz experiment, lasers
16, 17, 18	Mar 6, 11, 13	5	E	Wavelike Properties of Particles	De Broglie's hypothesis, Davisson-Germer experiment, wave packets, interpretation of wavefunction, Heisenberg uncertainty principle, particle-wave duality, Schroedinger eq (ch 7 in Thornton)
18, 19, 20, 21	Mar 13, 18, 20, 25	9	F	Statistical Physics	Boltzmann distribution, Maxwell distribution of speeds and kinetic energy
21, 22, 23, 24	Mar 25, 27, Apr 1, 8	12	G	Nuclear Physics	General history, techniques to observe radiation, carbon dating, radiation exposure, cosmic rays, properties of nuclei, nuclear stability, binding energy, angular momentum, magnetic moments, radioactivity, alpha/beta/gamma decay, nuclear force, Standard Model

Important dates and deadlines can be found here, including class suspension for fall and winter breaks, and statutory holidays.

Course-level learning outcomes:

This course mostly covers the start of the 20th century, where new physics phenomena were found that could not be explained with the older, classical physics. The course is designed to provide a logical transition from classical to modern physics. By the end of this course, you will understand the motivations behind the quantum mechanical view of nature and will have learned about some of the key experiments that have led to it. I hope that you will gain a deeper appreciation of modern physics and have fun learning about it! For sure, I will have fun teaching it. 😊Students are expected to attend all lectures and complete all assignments, knowledge checks, and exams.

Late and Missed Work Policies

Late assignments will not be accepted nor marked. Exemption or deferral of assignments, in-class mastery-of-knowledge checks, or midterm exam are only permitted for a medical or personal emergency or due to religious observance (request must be received within the first two weeks of the course). I (the course instructor) must be notified by e-mail prior to the due date or as soon as possible after the date, and the appropriate documentation must be submitted.

Assessments

Assignments: Approximately 7-8 assignments will be given throughout the semester. The assignment schedule will be announced in Brightspace, but will be approximately one assignment every one to two weeks. You are reminded to always retain a copy of all work that is submitted. Collaboration with your colleagues on the assignments is welcome, but collaboration does not mean copying! Please familiarise yourself with Carleton University's policies regarding plagiarism and academic honesty.

- You **must** submit your assignments electronically in Brightspace, by uploading a file in PDF or Microsoft Word format. **No other format is accepted.** Do not email your assignment to me or the TA. Do not submit your assignment in paper format.
- Assignments must be submitted no later than 11:59 p.m Eastern Time on the due dates. **Late assignments will not be accepted nor marked.**
- Students are expected to complete all assignments within the time frame allocated and by the dates indicated in Brightspace.

In-class mastery-of-knowledge checks: there will be approximately four in-class mastery-of-knowledge checks. These are brief sets of multiple-choice questions to be answered at the start of a class. They will be announced ahead of time in Brightspace. They are designed to give you feedback on whether or not you are mastering the concepts of the course. If you have a legitimate reason for missing a knowledge check, please notify your instructor by e-mail prior to the exam.

Mid-term exam: The midterm exam will be held in class on Friday, February 27, 2026, at 16:05 p.m. – 17:25 p.m. If you have a legitimate reason for missing the midterm exam, please notify your instructor by e-mail prior to the exam. More details about the midterm exam will be announced at a later date in Brightspace.

Final exam: The final examination will be held during the winter exam period, April 11-23, 2026. The date and time of the exam are scheduled by the central University scheduling service and will be announced part of the way through the term. More details about the exam will be announced at a later date.

Grade Breakdown for PHYS2004 and PHYS2605:

COMPONENT	GRADE VALUE
ASSIGNMENTS (7 OR 8 OF THEM)	25 %
IN-CLASS MASTERY-OF-KNOWLEDGE CHECKS	10 %
MIDTERM EXAM	25 %
FINAL EXAM	40 %
TOTAL	100 %

Passing conditions:

- An overall grade of greater than 50% is needed to pass the course.
- Students must obtain a minimum term grade of 30% (i.e. term grade is the sum of the assignments plus in-class mastery-of-knowledge checks plus midterm exam) in order to pass the course.
- Students must submit at least 4 of the assignments.
- The final exam must be attempted, even if you achieve 50% overall without it.

Deferred Exams: Deferred Exams for winter 2026 are scheduled for May 15-27, 2026. Deferred Exams are generally only granted to students who cannot take the regularly scheduled exam due to serious illness or death of a family member. Information on the deferral process is provided at https://carleton.ca/registrar/special-requests/deferral/
The Deferred Exam replaces only the Final Exam portion of the marks. Students must be eligible to pass the course by having completed satisfactory term work in order to be granted this privilege. In this context, satisfactory term work means that the term grade must be a minimum of 30% of the total grade (excluding the final exam), i.e. at least 18/60.

Academic Accommodations and Regulations

Carleton is committed to providing academic accessibility for all. You may need special arrangements to meet your academic obligations during the term. Accommodation request processes are outlined on the Academic Accommodations website.

Statement on Chat GPT/Generative AI usage

Students may use AI tools for basic word processing and text formatting. It is not necessary to document the use of AI for these purposes. **AI tools should not be used to find solutions to the assignments** as performing the work yourself is how you learn physics. If you have questions, please ask your instructor. As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with your instructor to ensure it supports the learning goals for the course.

Statement on Academic Integrity

Students are expected to uphold the values of academic integrity, which include fairness, honesty, trust, and responsibility. Examples of actions that compromise these values include but are not limited to plagiarism, accessing unauthorized sites for assignments or tests, unauthorized collaboration on assignments or exams, and using artificial intelligence tools such as ChatGPT when your assessment instructions say it is not permitted.

Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in Carleton University's Academic Integrity Policy. A list of standard sanctions in the Faculty of Science can be found here. Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and abide by Carleton University's Academic Integrity Policy.

Student Rights & Responsibilities

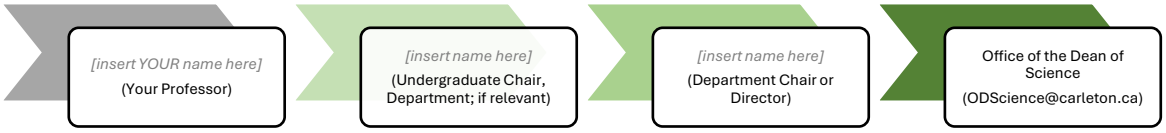
Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the Rights and Responsibilities Policy for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

Intellectual Property

All course materials are protected by copyright and remain the intellectual property of their respective author(s). Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

Student Concerns

If a concern arises regarding this course, **your first point of contact is me, your instructor**: Email or chat during student hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are in this order (**note:** You can also bring your concerns to Ombuds services):



University Policies

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52

F = <50
WDN = Withdrawn from the course
DEF = Deferred

Assistance for Students

Career Services: https://carleton.ca/career/
Centre for Student Academic Support: https://carleton.ca/csas/
Math Tutorial Centre: https://carleton.ca/math/math-tutorial-centre/
Science Student Success Centre: https://sssc.carleton.ca/

Online Community Expectations for Social Platforms

With the growing use of social platforms (e.g., Discord) on campuses, it is important to keep in mind that university codes of conduct still apply to the behaviours of students online. Please be considerate and respectful while engaging with peers and remember that we are all humans, and that your words matter. If any student witnesses or experiences harassment, I encourage you to reach out to me. Alternatively, you can contact Ombuds Services or Carleton Equity and Inclusive Communities.

Online communities can be highly beneficial to students and can help to facilitate learning within the course. I encourage people to ask questions, learn from one another, and have open discussions about class material. That said, any acts of academic misconduct (i.e., cheating) will not be tolerated and will result in serious consequences ranging from a grade reduction to expulsion (see academic integrity violations).

- Examples of appropriate peer-to-peer sharing/learning vary from course to course. In this course appropriate peer-to-peer sharing includes: identifying the proper formula to use, identifying an incorrect or missing step in a person's work, brainstorming potential reasons behind a concept, suggesting helpful sites and videos for learning a concept, posting your own work showing only a specific step or process for illustrative purposes (note: this is very different from posting your work and solution for others to simply copy)
- Examples of unacceptable peer-to-peer sharing: Posting or sharing the answers, indicating which answers are correct on assignments, sharing links to solutions, posting your own complete work for a question/solution

If you are concerned, confused, or conflicted over something, please reach out to me through email for help. Let's do our best to support one another in this class and keep the online experience a safe, inclusive, and positive experience for everyone.