



COURSE OUTLINE

1. **Course:** PHYS 229, Modern Physics - Winter 2022

Lecture 01 : MWF 10:00 - 10:50 in CHC 119

Instructor	Email	Phone	Office	Hours
Dr Timothy Friesen	timothy.friesen@ucalgary.ca	403 220-6123	SB 513	W 14:00 - 15:00

To account for any necessary transition to remote learning in the winter 2022 semester, courses with in-person lectures, labs, or tutorials may be shifted to remote delivery for a certain period of time. In addition, adjustments may be made to the modality and format of assessments and deadlines, as well as to other course components and/or requirements, so that all coursework tasks are in line with the necessary and evolving health precautions for all involved (students and staff).

In Person Delivery Details:

This is an in-person course and labs and lectures will be done in-person*.

*Lectures will be online if required by the university due to the ongoing pandemic. The first two labs will be online but the remainder will be in-person. Steps will be taken to minimize the number of students in each laboratory room.

Re-Entry Protocol for Labs and Classrooms:

To limit the spread of COVID-19 on campus, the University of Calgary has implemented safety measures to ensure the campus is a safe and welcoming space for students, faculty and staff. The most current safety information for campus can be found [here](#). **Online Delivery Details:**

This course is being offered online in real-time via scheduled meeting times, you are required to be online at the same time.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor's permission.

This course has a registrar scheduled, synchronous final exam. The writing time is 2 hours + 50% buffer time.

The first two labs of the term will be online, the remainder will be in-person.

The three quizzes and the final exam will be conducted online.

Course Site:

D2L: PHYS 229 L01-(Winter 2021)-Modern Physics

Note: Students must use their U of C account for all course correspondence.

Equity Diversity & Inclusion:

The University of Calgary is committed to creating an equitable, diverse and inclusive campus, and condemns harm and discrimination of any form. We value all persons regardless of their race, gender, ethnicity, age, LGBTQIA2S+ identity and expression, disability, religion, spirituality, and socioeconomic status. The Faculty of Science strives to extend these values in every aspect of our courses, research, and teachings to better promote academic excellence and foster belonging for all.

The Physics and Astronomy EDI Committee acknowledges there are persistent barriers that prevent such accessibility and hinder our progress towards EDI. Our representatives (faculty, postdocs, graduate and undergraduate students) are committed to addressing any concerns and work towards proactive solutions that enact necessary change within the department. To submit anonymous questions, comments or concerns

regarding EDI related issues, please reach out to our Acting Associate Head EDI, Jo-Anne Brown (jocat@ucalgary.ca)

2. Requisites:

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

Prerequisite(s):

3 units from Physics 211, 221 or 227; and 3 units from Mathematics 249, 265 or 275. Also known as: (formerly Physics 325)

3. Grading:

The University policy on grading and related matters is described in [F.1](#) and [F.2](#) of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

Course Component	Weight	Due Date (duration for exams)	Modality for exams	Location for exams
Tophat ¹	4%	Ongoing		
Assignments ²	18%	Ongoing		
Presentation	8%	Ongoing		
Laboratory Reports	25%	Ongoing		
Practice Quiz ³	1%	Jan 28 2022		
Quiz 1 ⁴	8%	Feb 04 2022		
Quiz 2 ⁵	8%	Mar 04 2022		
Quiz 3 ⁶	8%	Mar 25 2022		
Registrar Scheduled Final Exam	20%	Will be available when the final exam schedule is released by the Registrar	online	Will be available when the final exam schedule is released by the Registrar

¹ There will be in-class tophat questions throughout the term. To allow for inevitable absences through the term your final tophat participation grade will be marked out of 80 rather than 100. Example 1: if you complete 80% of the tophat questions correctly your final tophat grade will be 100% (4/4). Example 2: if you complete 90% of the tophat questions correctly your final tophat grade will be 100% (4/4). Example 3: if you complete 50% of the tophat questions correctly your final tophat grade will be 62.5% (2.5/4).

² There will be 8 assignments to complete through the term. Your final assignment grade will be your best 7 of 8 assignments. See the course schedule below for assignment due dates.

³ This timed assessment will be available on D2L on Jan 28th at 10 am. You will have 50 minutes to complete and submit it.

⁴ This timed assessment will be available on D2L on Feb 4th at 10 am. You will have 50 minutes to complete and submit it.

⁵ This timed assessment will be available on D2L on Mar 4th at 10 am. You will have 50 minutes to complete and submit it.

⁶ This timed assessment will be available on D2L on Mar 25th at 10 am. You will have 50 minutes to complete and submit it.

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum % Required	95 %	90 %	85 %	80%	75%	70 %	65 %	60%	55%	50 %	45 %

This course will have a Registrar Scheduled Final exam that will be delivered on-line. [The Final Examination Schedule](#) will be published by the Registrar's Office approximately one month after the start of the term. The final exam for this course will be designed to be completed within 2 hours.

Per section [G.5](#) of the online Academic Calendar, timed final exams administered using an on-line platform, such as D2L, will be available on the platform. Due to the scheduling of the final exams, the additional time will be

added to **the end** of the registrar scheduled **synchronous** exam to support students. This way, your exam schedule accurately reflects the **start time** of the exam for any **synchronous** exams. E.g. If a **synchronous** exam is designed for 2 hours and the final exam is scheduled from 9-11am in your student centre, the additional time will be added to the **end** time of the **synchronous** exam. This means that if the exam has a 1 hour buffer time, a synchronous exam would start at 9 am and finish at 12pm.

The University of Calgary offers a [flexible grade option](https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade), Credit Granted (CG) to support student's breadth of learning and student wellness. Faculty units may have additional requirements or restrictions for the use of the CG grade at the faculty, degree or program level. To see the full list of Faculty of Science courses where CG is not eligible, please visit the following website: <https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade>

4. **Missed Components Of Term Work:**

The university has suspended the requirement for students to provide evidence for absences. Please do not attend medical clinics for medical notes or Commissioners for Oaths for statutory declarations.

In the event that a student legitimately fails to submit any online assessment on time (e.g. due to illness etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date. Absences not reported within 48 hours will not be accommodated. If an excused absence is approved, one possible arrangement is that the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course. This option is at the discretion of the coordinator and may not be a viable option based on the design of this course.

Missed Quiz

Students who miss a quiz for a valid reasons will be granted an excused absence by the Instructor. Students must notify the Instructor by email within 48 hours of the missed quiz. The weight of the quiz will be distributed across the other quizzes and the final.

Missed Lab

If you miss a lab session for valid reasons please email your lab TA and your instructor as soon as possible (within 48 hours of the missed lab). Arrangements will be made (including make-up labs) on a case-by-case basis.

5. **Scheduled Out-of-Class Activities:**

There are no scheduled out of class activities for this course.

6. **Course Materials:**

Required Textbook(s):

Kenneth Krane, *Modern Physics*: Wiley, 4th edition, 2020.

Extra problems, laboratory documents, and supporting lecture material will be posted on the course D2L website.

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC [ELearning](#) online website.

7. Examination Policy:

The quizzes and the final exam will be open book, synchronous, online examinations. Access to the quiz and submission will occur on D2L.

Students should also read the Calendar, [Section G](#), on Examinations.

8. Approved Mandatory And Optional Course Supplemental Fees:

There are no mandatory or optional course supplemental fees for this course.

9. Writing Across The Curriculum Statement:

For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section [E.2](#) of the University Calendar.

10. Human Studies Statement:

Students will not participate as subjects or researchers in human studies.

See also [Section E.5](#) of the University Calendar.

11. Reappraisal Of Grades:

A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See [Section I.3](#) of the University Calendar.

- a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work form to the department in which the course is offered within 2 business days of receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections [I.1](#) and [I.2](#) of the University Calendar
- b. **Final Exam:** The student shall submit the request to Enrolment Services. See [Section I.3](#) of the University Calendar.

12. Other Important Information For Students:

- a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, [Mental Health Services Website](#)) and the Campus Mental Health Strategy website ([Mental Health](#)).
- b. **SU Wellness Services:** For more information, see www.ucalgary.ca/wellnesscentre or call [403-210-9355](tel:403-210-9355).
- c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email (syva@ucalgary.ca) or phone at [403-220-2208](tel:403-220-2208). The complete University of Calgary policy on sexual violence can be viewed at (<https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Sexual-and-Gender-Based-Violence-Policy.pdf>)
- d. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional [Code of Conduct](#) and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without

the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

[Student Handbook on Academic Integrity](#)
Student Academic Misconduct [Policy](#) and [Procedure](#)
[Research Integrity Policy](#)

Additional information is available on the [Student Success Centre Academic Integrity page](#)

e. Academic Accommodation Policy:

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf>.

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, by filling out the [Request for Academic Accommodation Form](#) and sending it to Dr. David Feder by email phas.ahugrd@ucalgary.ca preferably 10 business days before the due date of an assessment or scheduled absence.

f. Freedom of Information and Privacy: This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see [Legal Services](#) website.

g. Student Union Information: [VP Academic](#), Phone: [403-220-3911](tel:403-220-3911) Email: suvpaca@ucalgary.ca. SU Faculty Rep., Phone: [403-220-3913](tel:403-220-3913) Email: sciencerep@su.ucalgary.ca. [Student Ombudsman](#), Email: ombuds@ucalgary.ca.

h. Surveys: At the University of Calgary, feedback through the Universal Student Ratings of Instruction ([USRI](#)) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

i. Copyright of Course Materials: All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or [non-academic misconduct](#), in addition to any other remedies available at law.

Additional Information

Course Description

The goal of this course is to survey some of the significant challenges physics encountered in the 20th century and the solutions and their applications. An emphasis is placed on the experimental observations that led to the development of quantum mechanics and special relativity.

Topics include: Special Theory of Relativity, Electromagnetic waves, Blackbody radiation, Photoelectric Effect, X-rays and Bragg Diffraction, Compton Scattering, Atomic Structure, The Bohr Model, Atomic Spectra, Applications of the Schrödinger Wave Equation, Radioactivity, Nuclear Stability, Nucleosynthesis, Structure of the Nucleus, Elementary Particles.

Problem-Solving Lectures

Throughout the term there will be eight special lectures which will have a mixed tutorial and lecture format.

These will take place during the assigned lectures on Fridays (10:00 to 10:50) in ENC 70 (or online if the university does not allow in-person classes). The objective of the tutorial lectures is to give you an opportunity to work in a supported environment to solve problems related to the course material. A set of problems will be posted on Monday prior to the tutorial.

Assignments

There will be eight assignments throughout the term consisting of one or two problems for submission. These assigned questions will be part of a larger problem-solving set distributed a week before the deadline and worked on together in the Problem-solving Lectures. Your best 7 out of 8 assignments will form the Assignment component of your grade. All assignments must be submitted via D2L before 10 am on the dates in the schedule below.

Quizzes

There are three quizzes throughout the course scheduled for Friday Feb. 4th, Friday Mar. 4th, and Friday March 25th from 10:00 to 10:50. Quizzes will be done online and synchronously. They will be open-book. These quizzes are designed to take 50 minutes to complete and submit to D2L.

A practice quiz will occur on Jan. 28th from 10:00 to 10:50 (online as well). This quiz will help you get adjusted to the format and time pressure of a real quiz. Completion of this practice quiz will be worth 1% of your final grade (and form part of the 5% for participation).

Laboratory

The laboratory component of Phys229 is an essential opportunity for you to experience some of the exciting phenomena encountered in this course. Laboratory manuals will be available on D2L. Each laboratory exercise is accompanied by Pre-lab Questions. You must read over the laboratory exercise and complete these questions prior to entering the laboratory and working on the experiment. Your TA will check that these questions are complete at the start of the session.

The laboratory exercises begin the week of Jan. 17th. The first two labs will be conducted online over Zoom in a synchronous fashion. Thereafter all labs will be in-person in Science Theatres. A maximum of 3 groups (total of 9 people) will be in a lab room at a given time. A detailed schedule for when and where your labs will occur each week will be circulated when we return to in-person labs.

Starting the week of Feb. 14th you will have the choice of 3 of 6 possible experiments to conduct over the course of 6 weeks. One of the experiments must be chosen from Compton Scattering, Rutherford Scattering, and Nuclear Decay. Your laboratory TA will work with you to make the selection and coordinate when you perform an experiment. Note that the Nuclear Decay and Rutherford Scattering experiments require at least 24hrs to complete and a limited amount of time outside of your scheduled laboratory section may be needed to complete each experiment. Your group will submit one laboratory report for each of the 3 experiments.

The grading criteria and format for the laboratory reports will be discussed in the lectures. Your laboratory grade will include a peer evaluation component.

Presentation

At the end of the term you and your group will give a presentation of a Modern Physics topic of your choice. Your topic must be connected to the material covered during the term. This could mean covering a topic in more depth than was done in the lectures or a topic that is closely related to something we saw during the term. Your presentation could cover current research being done or provide a more historical perspective. Presentations will occur during your lab session and be evaluated by your TAs and your peers.

Group Work

The PHYS229 labs and group presentation will require you to work effectively as a group. The ability to do so is a critical soft-skill that will benefit your future university education and career regardless of your chosen path. Each group member must make equal contributions to all group labs and presentations. The current environment presents challenges for all of us and can make group work and coordination more challenging. As you work with your group it is important to understand that each group member may be facing unknown challenges. Above all else it is important to communicate, be empathetic, and help each other out. During the term there will be peer evaluations where you can evaluate each group member’s contribution, including your own. These evaluations will affect your final laboratory grade and group presentation grade.

Course Schedule

Below is the tentative lecture schedule as well as the schedule for quizzes, labs, and assignments.

Date	Lecture Content	Text Section	Lab	Assignments
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10-Jan	Introduction, Galilean transformations	2.1, 2.2	No Labs	
12-Jan	Einstein's Postulates, Lorentz transformation	2.3, 2.4, 2.5		
14-Jan	Experimental uncertainty			
17-Jan	Length Contraction	2.5	Radioactive Decay (Online)	
19-Jan	Time Dilation	2.6		
21-Jan	Problem-solving tutorial			
24-Jan	Relativistic Energy and Momentum	2.7	Electron Diffraction (Online)	Assign. 1 due
26-Jan	Energy and momentum conservation	2.8		
28-Jan	Practice Quiz (online)			
31-Jan	Electromagnetic Waves, Photoelectric Effect	3.1, 3.2	Evidence for Quantized Energy Levels	Assign. 2 due
2-Feb	Planck's Blackbody Radiation	3.3		
4-Feb	Quiz #1 (online)			
7-Feb	Compton Scattering	3.4	Hydrogen Balmer Series	
9-Feb	Atomic structure	6.1 - 6.3		
11-Feb	Problem-solving tutorial			
14-Feb	Bohr's Postulate and the Bohr Model	6.4 - 6.8	Rotating experiments	Assign. 3 due
16-Feb	de Broglie Matter Waves	4.1 - 4.3		
18-Feb	Problem-solving tutorial			
21-Feb	Reading Break		No Labs	
23-Feb	Reading Break			
25-Feb	Reading Break			
28-Feb	Wave Packets, Heisenberg Uncertainty Principle	4.3 - 4.5	Rotating experiments. Choose 3 of 6: Black Body Radiation Compton Scattering* Faraday Effect Nuclear Decay* Photoelectric Effect Rutherford Scattering* *A starred lab must be 1 of your 3 choices	Assign. 4 due
2-Mar	The Born Postulate, Probability Densities, Expectation Values	4.5 - 4.6		
4-Mar	Quiz #2 (online)			
7-Mar	The Schrödinger Wave Equation	5.1		
9-Mar	Free particle	5.1 - 5.3		
11-Mar	Problem-solving tutorial- Infinite Square Well			
14-Mar	Finite potential well, potential barriers	5.4		Assign. 5 due
16-Mar	Tunneling	5.5, 5.6		
18-Mar	Problem-solving tutorial- QM discussion			
21-Mar	Wave function and measurements	5.6		Assign. 6 due
23-Mar	Entanglement + the EPR paradox			
25-Mar	Quiz #3 (online)			
28-Mar	Hydrogen atom	7.1 - 7.3		
30-Mar	Hydrogen atom orbitals and angular momentum	7.4 - 7.5		
1-Apr	Problem-solving tutorial			
4-Apr	Spin and the Hydrogen spectrum	7.6 - 7.9	Presentations	Assign. 7 due
6-Apr	Nuclear structure	12.1 - 12.5		
8-Apr	Radioactivity	12.6 - 12.9		
11-Apr	Review			Assign. 8 due

Course Incomes

Physics 229 will introduce many new concepts and requires knowledge of classical mechanics and some knowledge of electromagnetism. This course will use calculus extensively so students should be comfortable with differentiation and integration as well as vectors.

Course Outcomes:

- Recognize the equivalence of matter and energy
- Justify the role of photons and failure of classical physics to explain blackbody radiation, the photoelectric effect and Compton scattering
- Recognize that simple microscopic systems must be described by probability densities using one dimensional, time independent Schrödinger wave equations
- Calculate physical observables for simple interactions and relate them to experimental outcomes

- Collaborate in a group to execute laboratory experiments
- Demonstrate proper laboratory techniques including data acquisition, analysis of data and uncertainty, and safe operation of equipment
- Clearly and accurately communicate concepts and arguments in writing and through scientific presentations

Electronically Approved - Jan 21 2022 08:54

Department Approval

Electronically Approved - Jan 22 2022 21:27

Associate Dean's Approval