



**COURSE OUTLINE**

1. **Course:** PHYS 325, Modern Physics - Winter 2019

Lecture 01: MWF 09:00 - 09:50 in ENG 224

Instructor	Email	Phone	Office	Hours
Timothy Friesen	timothy.friesen@ucalgary.ca	403 220-6123	SB 513	M, 13:00 - 15:00

**Course Site:**

D2L: PHYS 325 L01-(Winter 2019)-Modern Physics

Department of Physics & Astronomy: Science B 605, 403 220-5385, office@phas.ucalgary.ca

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

2. **Requisites:**

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

**Prerequisite(s):**

Physics 211 or 221 or 227; and 223 or 255 or 259 or 355; and Mathematics 211 or 213; and Mathematics 249 or 251 or 265 or 275 or Applied Mathematics 217.

**Antirequisite(s):**

Credit for Physics 325 and 209 will not be allowed.

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:

Component(s)	Weighting %
Tutorials (8)	25
Quizzes (3)	25
Laboratory Reports (9)	25
Poster Presentation	5
Final Examination	20

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
<b>Minimum % Required</b>	95 %	90 %	85 %	80%	75%	70 %	65 %	60%	55%	50 %	45 %

This course has a registrar scheduled final exam.

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

In the event that a student misses the midterm or any course work due to illness, supporting documentation, such as a medical note or a statutory declaration will be required (see [Section N.1](#); for more information regarding the use of statutory declaration/medical notes, see [FAQ](#)). Absences must be reported within 48 hrs.

The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize themselves with these regulations. See also [Section E.3](#) of the University Calendar.

#### 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, 3rd edition, 2012.

Online Course Components: Tutorials and supporting lecture material will be posted on the course D2L website. Laboratory information will be posted at the Physics Junior Laboratory website <http://www.pjl.ucalgary.ca/>

#### 7. **Examination Policy:**

For all quizzes and examinations a Schulich-approved calculator is allowed. Otherwise, no additional aids are permitted.

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 **15 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 immediately submit the Reappraisal of Graded Term work form to the department in which the course is offered. The department will arrange for a re-assessment of the work if, and only if, the student has sufficient academic grounds. 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 Center:** The Students Union Wellness Centre provides health and wellness support for students including information and counselling on physical health, mental health and nutrition. For more information, see [www.ucalgary.ca/wellnesscentre](http://www.ucalgary.ca/wellnesscentre) or call [403-210-9355](tel:403-210-9355).
- c. **Sexual Violence:** The University of Calgary is committed to fostering a safe, productive learning environment. The Sexual Violence Policy (<https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf>) is a fundamental element in creating and sustaining a safer campus environment for all community members. We understand that sexual violence can undermine students' academic success and we encourage students who have experienced some form of sexual misconduct to talk to someone about their experience, so they can get the support they need. 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 ([svsa@ucalgary.ca](mailto:svsa@ucalgary.ca)) or phone at [403-220-2208](tel:403-220-2208).
- d. **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K](#). Student Misconduct to inform yourself of definitions, processes and penalties. Examples of academic misconduct may include: submitting or presenting work as if it were the student's own work when it is not; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; collaborating in whole or in part without prior agreement of the instructor; borrowing experimental values from others without the instructor's approval; falsification/ fabrication of experimental values in a report. **These are only examples.**
- e. **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).
- f. **Academic Accommodation Policy:** Students needing an accommodation because of a disability or medical condition should contact Student Accessibility Services in accordance with the procedure for accommodations for students with disabilities available at [procedure-for-accommodations-for-students-with-disabilities.pdf](#).  
  
Students needing an accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics & Astronomy, Dr. David Feder by email [phas.ahugrd@ucalgary.ca](mailto:phas.ahugrd@ucalgary.ca) or phone [403-220-8127](tel:403-220-8127). Religious accommodation requests relating to class, test or exam scheduling or absences must be submitted no later than **14 days** prior to the date in question. See [Section E.4](#) of the University Calendar.
- g. **Safewalk:** Campus Security will escort individuals day or night (See the [Campus Safewalk](#) website). Call [403-220-5333](tel:403-220-5333) for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
- h. **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.
- i. **Student Union Information:** [VP Academic](#), Phone: [403-220-3911](tel:403-220-3911) Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca). SU Faculty Rep., Phone: [403-220-3913](tel:403-220-3913) Email: [sciencerep@su.ucalgary.ca](mailto:sciencerep@su.ucalgary.ca). Student Ombudsman, Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca).
- j. **Internet and Electronic Device Information:** Unless instructed otherwise, cell phones should be turned off during class. All communication with other individuals via laptop, tablet, smart phone or other device is

prohibited during class unless specifically permitted by the instructor. Students that violate this policy may be asked to leave the classroom. Repeated violations may result in a charge of misconduct.

- k. **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.
- l. **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 importance of experiments in 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.

### Tutorial 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 (09:00 to 09:50) in ENG 224. 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. At the end of the session, you will hand in one or two problems (indicated on the question sheet) to be graded. These will count towards the Tutorial component in the course .

### Quizzes

There are three quizzes throughout the course scheduled for Friday February 1, Friday March 1, and Friday March 22 from 09:00 to 09:50 in ENG 224. The first 20 minutes of the quiz are to be done independently. This will be followed by 15 minutes when you can work collectively in pre-assigned groups on a related problem. Eighty percent of the grade for the quiz will come from your independent work and twenty percent from the group work. Your score will not be lower than the work you did independently. Quizzes are closed-book and you may only use a Schulich-approved calculator and the equation sheet provided for the exam (a copy of which is posted on the D2L website for the course).

### Laboratory

The laboratory component of Phys325 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 January 21st and take place in ST 029. The first four lab reports must be completed during the laboratory period and handed in to the TA before the end of your laboratory session. After the Reading Break (February 18th to February 22nd), you and your group can select to do five experiments from a list of seven. Two 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 experiments including Nuclear Decay and Rutherford Scattering require several days 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 the five experiments completed after the Reading Break and the same grade will be applied to all members of the group. The grading criteria and format for the laboratory reports will be discussed in the lectures.

Laboratory Schedule:

Week	Name
Jan 21 <sup>st</sup> - 25 <sup>th</sup>	Planck's Constant with LEDs
Jan 28 <sup>th</sup> - Feb 1 <sup>st</sup>	Evidence for Quantized Atomic Energy Levels
Feb 4 <sup>th</sup> - Feb 8 <sup>th</sup>	Electron Diffraction
Feb 11 <sup>th</sup> - Feb 15 <sup>th</sup>	Radioactive Decay
Feb 18 <sup>th</sup> - Feb 22 <sup>nd</sup>	Reading week, no labs
Feb 25 <sup>th</sup> - Mar 1 <sup>st</sup>	Rotating experiments, choose 5 of 7 from:
Mar 4 <sup>th</sup> - Mar 8 <sup>th</sup>	Black Body Radiation
Mar 11 <sup>th</sup> - Mar 15 <sup>th</sup>	Colour Temperature
Mar 18 <sup>th</sup> - Mar 22 <sup>nd</sup>	Compton Scattering*
Mar 25 <sup>th</sup> - Mar 29 <sup>th</sup>	Faraday Effect
	Nuclear Decay*
	Photoelectric Effect
Apr 1 <sup>st</sup> - Apr 5 <sup>th</sup>	Rutherford Scattering*

\* Starred labs must make up 2 of the 5 choices.

### Poster Presentation

You and your group will select one experiment to present in the form of a poster during a Symposium on Experiments in Modern Physics that will be held during from 09:00 to 11:00 on Friday, April 12. The poster presentation will last approximately two hours during which time you and your group members will discuss your results and conclusions with your peers and other members of the department. Laboratory TAs and the course instructor will grade your work and your responses to questions. Strategies for designing an effective poster as well as the criteria for grading will be discussed in the lectures. The same grade will be applied to all group members.

Below is the tentative lecture schedule, including dates for the tutorials and quizzes.

Lec #	Date	Content	Text Section
1	Jan 11	Galilean and Lorentzian Transformations	2.1, 2.2, 2.5
2	Jan 14	Einstein's Postulates, Length Contraction, Time Dilation	2.3, 2.4, 2.5
3	Jan 16	Relativistic Energy and Momentum Equations	2.7
4	Jan 18	Tutorial #1	
5	Jan 21	Relativistic Energy and Momentum Conservation	2.8
6	Jan 23	Planck's Blackbody Radiation	3.3
7	Jan 25	Tutorial #2	
8	Jan 28	Einstein and the Photoelectric Effect	3.2
9	Jan 30	Bragg Diffraction, Compton Scattering	3.1, 3.4
10	Feb 1	Quiz #1	
11	Feb 4	Rutherford Scattering	6.1 - 6.3
12	Feb 6	Bohr's Postulate and the Bohr Model	6.4 - 6.8
13	Feb 8	Tutorial #3	
14	Feb 11	de Broglie Matter Waves	4.1 - 4.3
15	Feb 13	The Born Postulate, Probability Densities, Wave Packets	4.5 - 4.6
16	Feb 15	Tutorial #4	
	Feb 18	Reading Break	
	Feb 20	Reading Break	
	Feb 22	Reading Break	
17	Feb 25	Expectation Values	
18	Feb 27	Position, Momentum, and Energy Operators	
19	Mar 1	Quiz #2	
20	Mar 4	Heisenberg Uncertainty Principle	4.4
21	Mar 6	The Schrödinger Wave Equation	5.1 - 5.3
22	Mar 8	Tutorial #5	

23	Mar 11	One dimensional infinite potential well, Eigenfunction, Eigenvalue	5.4
24	Mar 13	Normalization, Expectation Values, SWE in 2 Dimensions	5.4
25	Mar 15	Tutorial #6	
26	Mar 18	Harmonic Oscillator, Potential Barriers and Unbound States	5.5, 5.6
27	Mar 20	Tunneling	
28	Mar 22	Quiz #3	
29	Mar 25	Hydrogen atom and Orbital Angular Momentum	7.1 - 7.3
30	Mar 27	Radial Probability Density	7.4 - 7.5
31	Mar 29	Tutorial #7	
32	Apr 1	Zeeman Effect, Stern-Gerlach, Spin Angular Momentum	7.6 - 7.9
33	Apr 3	Radioactivity and Nuclear Decay	12.1 - 12.6
34	Apr 5	Tutorial #8	
35	Apr 8	Alpha, Beta and Gamma Decay	12.7 - 12.9
36	Apr 10	Natural Decay Chain, Fission, Nuclear Reactors	12.10, 13.1-13.4
37	Apr 12	Poster Presentations	

### Course Incomes

Physics 325 will introduce many new concepts, which will require knowledge of classical mechanics, electromagnetism, and thermal physics. This course will use calculus extensively so students should be comfortable with differentiation and integration as well as vectors. Some familiarity with eigenvalues, eigenvectors, differential equations, partial derivatives, and complex numbers will be helpful.

### 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

Department Approval:

Electronically Approved

Date: 2019-01-07 22:14