

Physics 128, Waves and Quanta (4 credits)

UVM Physics Department - Fall 2022

Class schedule:

Lecture: MWF 1:10-2:00 Lafayette 406

Lab: T 9:30-11:20 Discovery 403 (plus other times, experiment depending)

Instructor: Dr. Luke Donforth (he/him)

Office Hours: MW 2:30 – 3:30 or by appointment

Office: Innovation E227

Email: luke.donforth@uvm.edu (I will respond, but not on evenings or weekends.)

Phone: 802-656-0052 (landline, no text)

Please utilize office hours for help and/or to discuss interesting aspects of the physics we're studying. Answering questions about material is easiest in person. If you have questions about grading, please email so that we both have a record of the conversation.

TA information: David Allemeier (he/him)

Office Hours: Thursday 1:00 – 2:00, Discovery 403

Email: david.allemeier@uvm.edu

Pre-requisites: PHYS 152 or PHYS 125

Co-requisites: MATH 121

Education requirements satisfied: Submitted for, but pending approval: N2, QR

Course Description:

Waves and Quanta is an introduction to "Modern Physics", i.e., the revolutions of understanding that took place in the field over the 20th century. Topics covered include special and general relativity, particles and waves, introduction to quantum mechanics, atomic physics, statistical mechanics, molecules and solids. These will be explored from the perspective of theory in the lecture component of the course, and from the perspective of experiment, in the lab component.

Course Learning Objectives

Successfully completing this course means that you can

- Explain the foundational tenants of special relativity and use them to solve parameters such as size, speed, and time in different frames of reference.
- Distinguish when both matter and electromagnetic radiation function as particles and/or waves and apply appropriate calculations in those instances.
- Interpret Schrödinger's equation in introductory situations and make predictions based on quantum mechanics.
- Justify and measure outcomes from non-classical effects such as quantization and tunnelling.
- Calculate basic statistical mechanical properties like temperature and entropy. Utilize distributions, such as Boltzmann's, in predicting energy distributions.
- Recognize many-body systems, such as crystals and semi-conductors, where solid state physics provides analytic tools.

Required Course Materials:

Text: Modern Physics, 2nd Edition

Author: Randy Harris

ISBN-13: 978-0-8053-0308-7

The book is available at the UVM bookstore. One copy is on reserve at Howe Library.

You should have a scientific or graphing calculator that does not connect to the internet.

You will need a computer (see [CEMS Laptop Recommendations](#)) to access the course Blackboard page (bb.uvm.edu) which contains the lab manual and is where lab reports will be handed in, as well as the course Gradescope page which is where homework will be turned in and marked, and exams handed back. Gradescope is free, and information will be emailed to students. Students should either have access to a scanner, or plan on using programs such as LaTeX to write up their homework for digital submission. *Students struggling to pay for or obtain course materials or CEMS-approved laptops are encouraged to contact KC Williams, Assistant Dean of Equity, Belonging, and Student Engagement (kc.williams@uvm.edu) and/or [UVM Student Financial Services](#).*

Technical support for students

Students, please read this technology check list to make sure you are ready for classes.

<https://www.uvm.edu/it/kb/student-technology-resources/>

Students should contact the Helpline (802-656-2604) for support with technical issues.

Course Outline:

Week	Reading/Topic	Lab	Events
1	Ch 2: Relativity	No Lab	
2	Ch 2: Relativity	Orientation	Labor Day - Monday September 5 - No Class
3	Ch 2: Relativity	Speed of Light	Add/Drop Deadline Monday September 12
4	Ch 3: Waves & Particles 1	No Lab	Midterm on Wednesday, September 21
5	Ch 3 and Ch 4	Photoelectric Effect	
6	Ch 4: Waves & Particles 2	Microwave Diffraction	
7	Ch 5: Bound States	Electron Diffraction	Fall Recess – Friday October 14 - No Class
8	Ch 5: Bound States	Bohr Model	
9	Ch 6: Unbound States	No Lab	Midterm on Wednesday, October 26
10	Ch 7: Quantum Mechanics in 3D	Franck-Hertz	Last Day to Withdraw, Mon. Nov. 1
11	Ch 8: Spin & Atomic Physics	No Lab	
12	Ch 9: Statistical Mechanics	No Lab	
13	No Class	No Lab	Thanksgiving Break November 21-25
14	Ch 10: Molecules & Solids	Diodes	
15	Ch 10: Molecules & Solids	No Lab	Final Exam, Thursday, Dec. 15, 10:30 AM – 1:15 PM

Grading Criteria & Policies:

Each student will receive a total grade based on the grades of the exams, homework, laboratory work, and class participation. The individual components will be scaled and converted to letter grades according to:

Mid-terms 24% (12% each)

Final exam 16%

Laboratory work 25%

Homework 25%

Class participation 10%

$90\% \leq A- < 93\% \leq A < 97\% \leq A+ \leq 100\%$

$80\% \leq B- < 83\% \leq B < 87\% \leq B+ < 90\%$

$70\% \leq C- < 73\% \leq C < 77\% \leq C+ < 80\%$

$60\% \leq D- < 63\% \leq D < 67\% \leq D+ < 70\%$

$F < 60\%$

All grades will be posted on Blackboard to ensure privacy. It is each student's responsibility to verify the accuracy of the postings regularly. Report any discrepancies promptly.

Exam schedule

Midterm 1: in-class on Wednesday, September 21st, covering chapter 2.

Midterm 2: in-class on Wednesday, October 26th, covering chapters 3, 4, & 5.

Final: 10:30-1:15 on Thursday December 15th, cumulative (chapters 2 through 9).

Homework:

On all homework assignments, it is your responsibility to clearly express your solution to the problems. Any ambiguity in the handwriting or the logical progression of your solutions are open to interpretation and therefore may be considered wrong. It is not sufficient only to solve the problem correctly. You must also convince the reader that you have solved the problem correctly. Please either prepare your assignments on a computer, or else scan all handwritten pages of the homework assignment and submit as a single PDF file to the assignment dropbox on Gradescope. Late homework will be penalized 10% per day, up to the point when the solutions are released, after which no credit will be given for the assignment.

Homework #	Chapter	Problems	Due
0		Introduction	8/29
1	2	19, 22, 23, 26, 36, 37	W 9/7
2	2	45, 53, 64, 71, 74, 75, 81, 84, 93	W 9/14
3	3	11, 23, 28, 36, 40, 44	W 9/28
4	4	13, 18, 30, 33, 44, 46	F 10/7
5	4	48, 52, 54, 55	F 10/14
6	5	22, 24, 25, 36, 52, 54	F 10/21
7	5	55, 56, 57, 58	F 10/28
8	6	16, 18, 20, 22, 24, 25, 33, 47	W 11/9
9	7	20, 24, 25a, 30, 32, 37	W 11/16
10	7 & 8	7.43, 7.44 & 8.28, 8.29, 8.30, 8.35, 8.41	W 11/30
11	9	19, 22, 27, 30, 64	F 12/9

If due-dates for homework need to be shifted to match the course progression, it will be announced via the course website.

Labs:

There will be approximately weekly lab sessions in DISCOVERY W403. Safety is a priority. During labs, negligent or deliberate misuses of the equipment will not be tolerated, and may result in an F for the assignment or entire course. Also, all students must follow the University guidelines for prevention and mitigation of COVID-19. Download and read the weekly lab instructions prior to arrival in lab. A pre-lab quiz may be assigned on Blackboard for each lab and must be completed before lab begins. Attendance in labs is mandatory and make-up sessions will only be granted for students with legitimate excused absences or for groups who identify problems with data gathered during scheduled lab sessions where full effort was given to the lab material. Catching honest mistakes is a very beneficial skill in experimental science. Lab reports should be typed, and contain computer-generated figures and tables.

Lab reports should contain the following sections: Abstract, Introduction, Experimental Details, Results and Discussion, and Conclusion. Tables and figures should be labeled, and references to appropriate papers are always welcome. I highly recommend the use of LATEX typesetting language. Information is available on the course webpage.

Lab reports are due by 11:59 PM on the Monday following the lab experiment, and must be submitted as a PDF file on Blackboard.

Pedagogy:

During the MWF sessions, we'll cover material in discussion, group problem-solving, conceptual analysis, and lecture. A portion of your final grade is contingent on your participation in these sessions. You should read the pertinent sections of the textbook before coming to class, to be well prepared to participate in the discussions and problem solving. We will work together to develop a learning community that is inclusive and respectful; and that encourages and appreciates expressions of different ideas, opinions, and beliefs in the spirit of Our Common Ground. Meaningful and constructive dialogue is encouraged in this class. This requires mutual respect, willingness to listen, and open-mindedness to opposing points of view. Respect for individual differences and alternative viewpoints will be maintained at all times in this class. Conduct that substantially or repeatedly disrupts the ability of faculty and instructors to teach and the ability of students to engage may result in my asking a student to temporarily leave the classroom. [See Undergraduate Catalogue - Classroom Code of Conduct \(p. 443-444\).](#)

During the lab sessions, you'll have opportunities to explore the phenomenon with hands-on experiments and clarify your thinking by writing up your results and analysis. You should review the lab manual (online at the course page) before coming to class, so that you are ready to engage with the experiments. Your lab reports form a portion of your grade.

The UVM attendance policy can be found [here](#).

Part of the course is gaining facility calculating and solving to make predictions about outcomes. You'll have regular homework as opportunities to practice these skills. You are encouraged to work together on the homework (science is a collaborative endeavor); however, make sure that you can do the calculations yourself. Copying someone else's work is a violation of the [Code of Academic Integrity](#) and will be treated as such.

Our intention is for CEMS to be a place where you will be treated with respect and kindness. We welcome individuals of all ages, backgrounds, beliefs, interests, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of the College are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the community. If you ever feel that you have been unfairly treated or judged by an instructor, a mentor, another student, or another member of the CEMS community, please let someone know. Your instructors and advisors in the [CEMS Office of Student Services](#) are available to discuss any concerns or you can report an incident of bias through the [Campus Bias Response Program](#).

Land Acknowledgement:

UVM is located on the lands and waters which has long served as a site of meeting and exchange among indigenous peoples for thousands of years and is home of the Western Abenaki People. UVM honors, recognizes, and respects these peoples, especially the Abenaki, as the traditional stewards of the lands and waters on which we gather today. In that spirit, we begin by acknowledging we are guests in this land, and we need to respect and help protect the land and water within our use. In offering this land acknowledgement, UVM affirms Indigenous People's sovereignty, history, and experiences. We note that a land acknowledgement is only a beginning in a larger process of naming injustices and relationship building.

Attendance and illness:

If a student will not be able to attend in-person classes for qualifying health reasons, Student Health Services (SHS) will send a notification to the appropriate student services office or designated staff member informing them of this along with the dates the student is unable to attend. The SHS notification will specify whether the request for flexibility is only around in-person class attendance or includes additional flexibility for assignments and tests because the student is too ill to participate. Students are responsible for working with their faculty to make up class content and work they miss due to a documented illness.

Lived Name and Pronoun Information

The UVM Directory includes fields for indicating your lived name and your pronouns. Lived names (preferred names, names in use) are names that an individual wants to be known by in the University community. Entering your pronouns is strongly encouraged to help create a more inclusive and respectful campus community. To update your information, login to the UVM Directory. A preview box will allow you to see how this information will appear in other systems used on campus such as Microsoft Teams and Blackboard.

More information about how to make changes to your lived name and pronouns is available in the [Knowledge Base](#).

To read more about official UVM policies, events, and initiatives regarding diversity, equity, and inclusion: <https://www.uvm.edu/diversity>

Sexual Assault, Relationship Violence, Harassment, & Discrimination Disclosure:

All course instructors (including graduate and undergraduate students hired for the course) are “Responsible Employees” or mandatory reporters, meaning we are responsible for reporting to the Title IX Coordinator instances of sexual assault, intimate partner violence, harassment, and discrimination disclosed to any of us, including the names of the person that disclose the information, for institutional review. If you would like to speak confidentially with someone (i.e. someone not required to make a report for institutional review) you may contact the following resources directly for support:

[Campus Victim’s Advocacy](#)

[HOPE Works](#)

[UVM Counseling & Psychiatry Services](#)

[Student Health Center](#)

[UVM’s Affirmative Action and Equal Opportunity Office](#)

Course Evaluation:

All students are expected to complete a **mid-term** evaluation and final evaluation of each course they are enrolled in. Indicate that the evaluations will be anonymous and confidential, and that the information gained, including constructive criticisms, will be used to improve the course.

[Click here for instructions on how to access Blue course evaluations.](#)

Student Learning Accommodations:

In keeping with University policy, any student with a documented disability interested in utilizing ADA accommodations should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly recommended to discuss with their faculty the accommodations they plan to use in each course. Faculty who receive Letters of Accommodation with Disability Related Flexible accommodations will need to fill out the Disability Related Flexibility Agreement. Any questions from faculty or students on the agreement should be directed to the SAS specialist who is indicated on the letter.

Contact SAS:

A170 Living/Learning Center;

802-656-7753

access@uvm.edu

www.uvm.edu/access

Research and Citation Help

For help selecting research topics, finding information, citing sources, and more, ask a librarian. The UVM Libraries are eager to help. You may ask questions by phone, e-mail, chat, or text, or make an appointment for an individual consultation with a librarian.

Howe Library: <https://library.uvm.edu/askhowe>

Dana Medical Library: <https://dana.uvm.edu/help/ask>

Silver Special Collections Library: <https://specialcollections.uvm.edu/help/ask>

Regarding potential changes during the semester:

<http://catalogue.uvm.edu/>

The University of Vermont reserves the right to make changes in the course offerings, mode of delivery, degree requirements, charges, regulations, and procedures contained herein as educational, financial, and health, safety, and welfare considerations require, or as necessary to be compliant with governmental, accreditation, or public health directives.

Intellectual Property Statement/Prohibition on Sharing Academic Materials:

Students are prohibited from publicly sharing or selling academic materials that they did not author (for example: class syllabus, outlines or class presentations authored by the professor, practice questions, text from the textbook or other copyrighted class materials, etc.); and students are prohibited from sharing assessments (for example homework or a take-home examination). Violations will be handled under UVM's Intellectual Property policy and Code of Academic Integrity. **Please note that 'sharing assessments' includes course materials on study sites such as Chegg and Course Hero; and that uploading and downloading both count as unauthorized sharing.**

Important UVM Policies

Academic Integrity:

The policy addresses plagiarism, fabrication, collusion, and cheating.

<https://www.uvm.edu/policies/student/acadintegrity.pdf>

Code of Student Conduct:

[UVM's Code of Student Conduct](#) outlines conduct expectations as well as students' rights and responsibilities.

FERPA Rights Disclosure:

The purpose of UVM's [FERPA Rights Disclosure](#) is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974.

Final Exam Policy:

The University [final exam policy](#) outlines expectations during final exams and explains timing and process of examination period.

Grade Appeals:

If you would like to contest a grade, please follow the procedures [outlined in this policy](#).

Grading:

[This link](#) offers information on grading and GPA calculation.

Religious Holidays:

Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, please submit the dates of your absence to me in writing by the end of the second full week of classes. You will be permitted to make up work within a mutually agreed-upon time. The complete policy is [here](#).

Promoting Health & Safety:

The University of Vermont's number one priority is to support a healthy and safe community:

[Center for Health and Wellbeing](#)

[Counseling & Psychiatry Services \(CAPS\)](#) Direct Phone Line: (802) 656-3340

C.A.R.E. If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (802-656-3380). If you would like to remain anonymous, you can report your concerns online by [visiting the C.A.R.E. Team website](#).

Food Insecurity:

The UVM Center for Health & Wellbeing provides several on- and off-campus resources for students struggling with food insecurity: <https://www.uvm.edu/health/food-insecurity-uvm>

Statement on Alcohol and Cannabis in the Academic Environment

As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. In addition, alcohol and cannabis can:

- Cause issues with attention, memory and concentration
- Negatively impact the quality of how information is processed and ultimately stored
- Affect sleep patterns, which interferes with long-term memory formation

It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course. Thank you for taking Physics with us.