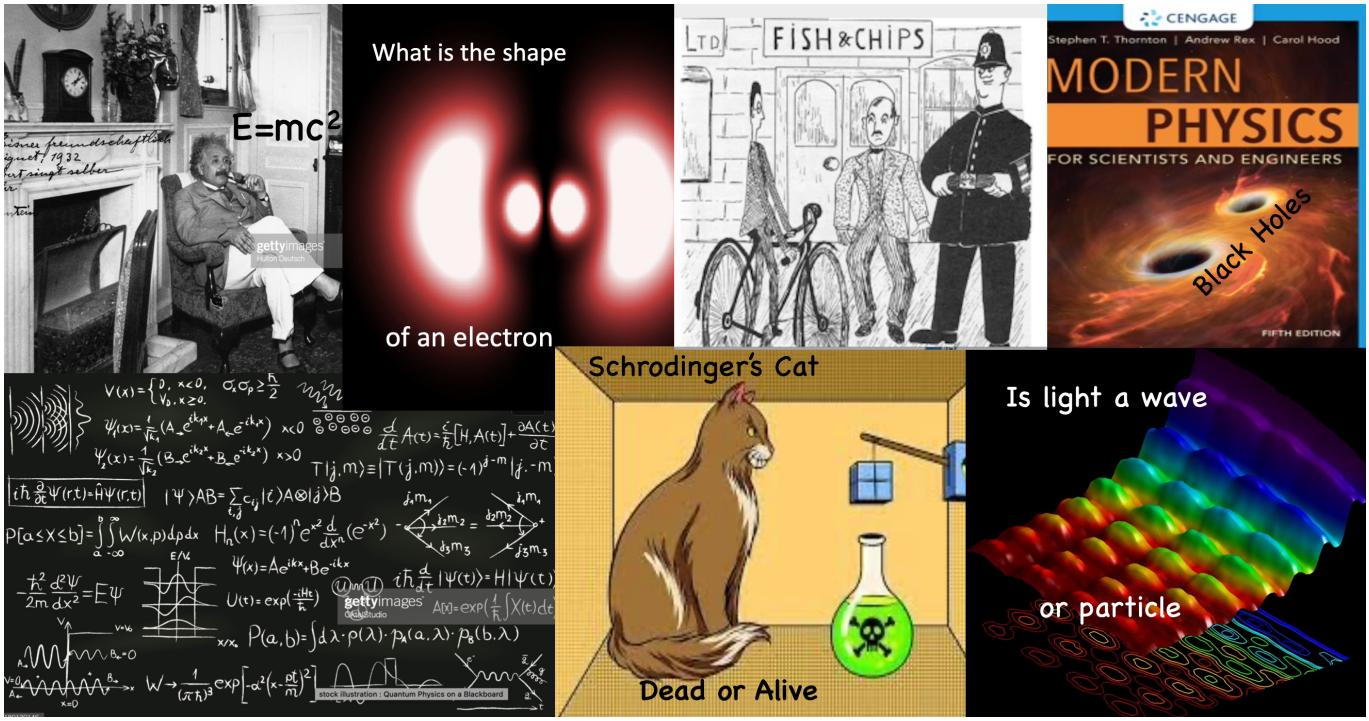
PHYS 2620 4 cr-hrs
Modern Physics
Syllabus
Summer Session I-II 2025
Instruction mode
Online (Synchronous*)
Updated April 9, 2025
Start Date: Monday May 19, 2025 – End Date: Saturday July 12, 2025
Class Time MTW 1:00 – 3:00 and TR 1:00 – 3:00

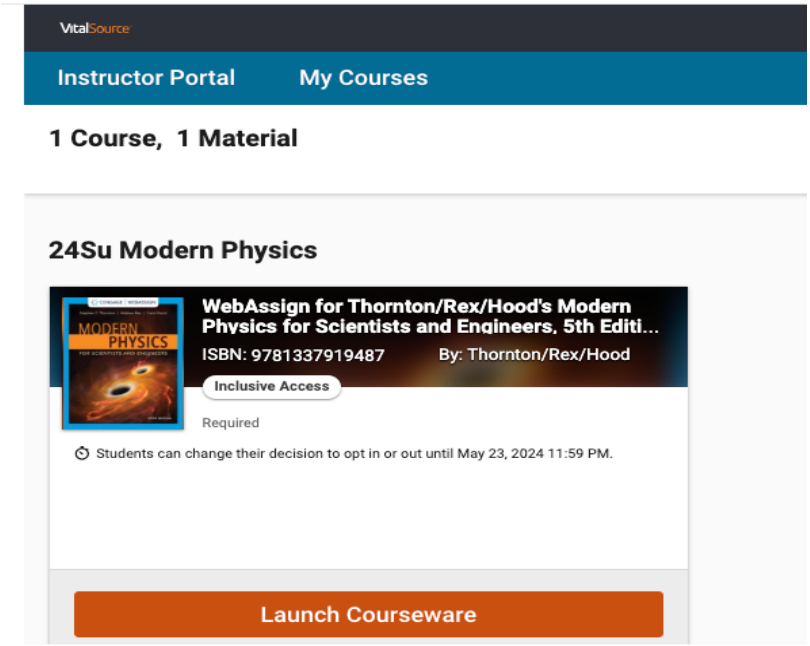


For registration details on Summer Session go to the link [summer session home](#) For course details see below

- **Course Overview:** Physics 2620 is a comprehensive study of modern physics that emphasizes concepts and problem solving. Modern physics generally means the breakthroughs in special relativity and quantum mechanics during the early 1900's. This course includes that part of classical physics that failed to explain certain well-known experiments. In the late 1800's classical physics consisted of Newton's Laws, Maxwell's equations, and thermodynamics. As these failures became more worrisome to prominent scientist, new ideas began to emerge and special relativity and quantum physics were born. This course is about the emergence of special relativity, quantum physics and the Schrodinger equation and application of the latter to new phenomena.

- **Synchronous Lectures*, Quizzes and Exams:** There are 44 lectures on MTWRF offered online. There is no penalty for missing an occasional online lecture. Lectures by the course instructor are automatically video/audio recorded for replay if you happen to miss a lecture or want to play it again. You can take it from anywhere in the world where you have a fast internet connection and a laptop or desktop computer. **Quizzes which are given on Tuesday or Thursday must be taken with unmuted video on Zoom on the given date and time on the calendar**. If you miss the quiz due to a daily job or doctor supported medical reasons, you must take the makeup offered at 7:00 pm on the same day. The midterm and final must be taken at the scheduled time.
  *Students who have other commitments such as a full-time work schedule during lecture time must request permission from the instructor to take the class self-paced (asynchronously), but still must meet the deadline dates and times for homework, quizzes, and exams.

- **Required Textbook:** Modern Physics for Scientists and Engineers, Stephen T. Thornton, Andrew Rex, and C. Hood, ed 5. Hard cover edition ISBN: 978-1-337-91945-6, Loose-leaf edition ISBN: 978-1-337-91956-2.
  After you register for the course, you will be able to access the digital textbook and course materials including WebAssign. Click on your **canvas link** and then click on **Courses** and then click on **24Su Modern Physics**. Click on **UVa Bookstore Inclusive Access** and you should see the image shown below. Click on **Launch Courseware** and you will get access to the above materials, digital book and resources. You will not see my assignments until I give you the start date which I usually give earlier than the first day of class. If you stay registered in the course up until the add/drop period, your UVa student fee account will automatically be billed $82.35. This price may vary. This includes the digital textbook, Cengage, and access to Webassign. This is a great savings. The hardcover, softcover or loose-leaf edition textbook may be ordered from the UVa Cavalier bookstore if desired. but at a higher price.



- **Course Topics**

Ch. 1 Classical Physics Review
Ch. 2 Special theory of relativity, Einstein's postulates, time dilation, contracted length, energy ...
Ch. 3 Particle and wave properties of matter, Planck's quantum and blackbody radiation, Photoelectric effect,…
Ch. 4 Classical atomic structure, Bohr model of atomic hydrogen, …
Ch. 5 De Broglie wavelength, Heisenberg uncertainty principle, wave functions …
Ch. 6 Schrodinger Wave equation, eigenvalues, square well potential, potential barriers, tunneling.…
Ch. 7 Application of Schrodinger equation, Hydrogen atom, quantum numbers, orbital motion and intrinsic spin.
Ch. 8 Periodic table. total angular momentum, and anomalous Zeeman effect.
Ch. 9 Statistical Physics
Ch. 10 Bonding and Rotational Spectra.
Ch. 12 Atomic nucleus, nuclear properties and forces, radioactivity, neutrinos, time dating using lead/carbon
Ch. 13 Nuclear physics, nuclear reactions, fission and fusion, reactors, and medical applications.
Ch. 14 Particle physics, accelerators, standard model, quarks, families of matter, and neutrino oscillations
Ch. 15 Astrophysics, stars, galaxies, gen. relativity, dark matter, and black holes
Ch. 16 Cosmology

- **Prerequisites:** This particular course offering is appropriate for engineering students who have completed the sequence PHYS 1425-2415 with Math 2310 at the University of Virginia and can be taken by science majors (including physics majors) who have taken various physics sequences: 2310-20 (no longer offered), or 1610-20 or 1710-20, and 2610, or possibly 2010-20 (with instructor permission). This course serves as a science/technical elective for engineering students. Visiting students should email the instructor (ral5q@virginia.edu) to discuss prerequisites for this class who have achieved at least a grade of C or better from physics courses equivalent to PHYS 2415 or 2610.

- **Online Course offered Summer Session**

Lecture Sessions	MWF 1:00-3:00	Online (Zoom
Discussion Sessions	TR 1:00-3:00	Online (Zoom)
Instructor:	Richard A Lindgren	ral5q@virginia.edu
	Emeritus Research Professor of Physics	Office Physics Bldg.
Office Hours	TR7:00-8:00pm	Online (Zoom)
• Teaching Assistant	TBA	TBA
Office Hours	MWF 7:00-8:00pm	Online (Zoom)

- **Lectures are scheduled for Monday, Wednesday, and Friday**
The course consist of approximately 44 lectures given on Monday, Wednesday and Friday. Two one-hour lectures are given on each day starting at 1:00 and 2:00 pm with a 5-minute break in-between lectures; Lectures will focus on developing the ideas surrounding the main physics concepts in each session, sometimes deriving important formulas (some of the time relying on you to derive the formulas). Many examples will be discussed in class including solving end of chapter problems. The main objective is to teach you modern physics by making the lecture material interesting and exciting and have you to develop a working knowledge of solving problems in modern physics. We will cover the physics discussed in Chapters 2-16 omitting Chapter 11 and briefly discuss Chapters 15 and 16. **Due to the pace of the course in such a short period of time and my own preferences for the material certain specialized topics in various chapters will be omitted, but this will not put your expertise of the subject matter at any disadvantage. Note that this is a 4 cr-hr course requiring more time than available in a single summer session I, II, or III. The course runs from the beginning of summer session I and ends at the end of summer session II.**

- **Lecture catch-up, Problem solving, Discussion and Quizzes are scheduled for Tuesday and Thursday**
  Additional examples of solving problems and discussion will be given on Tuesday starting at 1:00 pm and a discussion followed by a short quiz on Thursday starting at 2:00 pm The short quiz consisting of 5 numerical/conceptual problems will be about 30 minutes long. The quizzes will be part of your final grade. Tuesday and Thursday will also be used for catching up on the schedule and to reinforce understanding of particular topics.

- **Homework**
  Homework assignments will be posted on Canvas and linked to WebAssign through Cengage. It is due twice a week at 11:59 pm on different days of the week. Because this course is at such a rapid pace you must keep up every day and not get behind or all is lost. Having you submit homework every few days will help you not get lost. Students are encouraged to discuss problems with others while completing homework assignments. You may also post a question on Piazza to get even faster turn-around from your TA, or your Professor or from other students. However, each student is required to work out the final solution on their own. Copying homework solutions is an honor violation. Homework extensions will be accepted up to a day or so but may require a penalty depending on the situation. If you have a medical excuse, send me some documentation and no penalty will be given. Solution to many of the problems are available on WebAssign and will be available to you after the deadline for submission. Office hours are held on Zoom by your Professor on Tuesday (T) and Thursday(R) from 7:00 PM to 8:00 pm to answer questions and by the TA on MTWRF (Time to be announced later).

- **Exams**
  Exams include one midterm exam, and one final exam. The midterm will be given on June 13 Thursday on Zoom from 1:00 pm to 3:00 pm. The midterm will be posted on WebAssign. See Calendar for specific times of the quizzes and midterm. There could be some adjustment to the dates depending on our progress. All testing is open book, but obviously no searching the internet or communicating with others. All exams and quizzes are taken according to the rules set by the UVa honor code. Please review the code if you are not familiar with it. See next to last paragraph in these notes. You will be required to unmute video when attending lectures, taking quizzes, and taking exams. Canvas Lockdown Browser is being considered for exams.

- **Solutions posted on WebAssign**
  Solutions to homework, quizzes, and midterm will be posted on WebAssign.

- **WebAssign: Assignment platform for final, midterm, quizzes and homework**
  WebAssign will be used for taking the final, midterm, quizzes, and submitting homework. It allows for setting a time limit and dates for when the exam or homework is posted for future assignments. It also allows for different kind of feedback conditions for the student as discussed below. The final is timed for 3 hours. The midterm is timed for 2.0 hours and quizzes are timed for 30 minutes. The number of days between homework assignments varies. There may be some instances where quizzes may be also posted on Canvas or some other platform. If this happens, you will certainly be notified about the change.)

- I have elected the Inclusive Access Program that pairs WebAssign with the publisher Cengage and Canvas. Click on **UVa Bookstore Inclusive Access** This will give you access to WebAssign, the digital textbook, and other resources. You can still get familiar with WebAssign before class starts without access through Canvas. Click on this link https://webassign.net/manual/WA_Student_Quick_Start.pdf

- **Types of problems**
  Assignments could have many different types of problems allowed in WebAssign. Possible types are numerical problems where you submit one answer with the correct number of requested sig. fig., multiple choice where you select one or more answers, fill in the blank, or may be even algebraic where steps are submitted to derive a formula. In our class I will focus mostly on numerical problems and multiple-choice conceptually oriented questions. However, sometimes, I may deviate from this plan and ask a totally different type of question.

- **Significant figures (Sig. Fig.)**

When solving problems or answering questions on WebAssign, you will be given to what accuracy a calculation is needed and how many significant figures (sig. fig.) are needed for a correct answer. If you give too little or too many sig. fig. your answer will be incorrect. You should do the calculation with intermediate steps holding as many sig. fig. as reasonable but certainly more than what is requested for the final answer. If you need 2 sig. fig. to get the right answer, you should hold the intermediate steps to at least 4 sig. fig. and sometimes more depending on the specific calculation

- **Units**
  Most problems assigned will require numerical answers that have units. The answer box will generally have the units given to you. You must enter the answer with the correct units. Be sure to submit the WebAssign orientation assignment.

- **Answer feedback and resubmission**
  Depending whether you are working on an exam, quiz, or homework you will be given a chance to resubmit your answer. For example, if you submit your answer in the answer box, you will get either a green check mark (correct) or a red X (Incorrect). I will give you 6 chances to submit the answer again if it is a homework question to get it correct. Usually, I will allow 2 chances if it is a quiz or exam.

- **Lecture Slides:** All lecture slides original and annotated will be posted on Canvas. The video/audio digital recordings of all the lectures will be available on Media Gallery after transferring from the Cloud to Canvas.

- **Grading:** Your grade is based on several components, so no one component makes or breaks it.

Final Exam	- 30%
Midterm	- 25%
Quizzes	- 15%
Homework	- 25%
Attendance/Poll Questions	- 5%
Total	100%

  (If you do not attend the lectures, you do not receive the 5% and you do not have the opportunity to submit the Poll questions. Instead, your grade will be determined by the final, midterm, quizzes, and homework and renormalized by dividing your grade score by 0.95 to add up to 100%.)
  The lowest homework grade and lowest quiz grade will be dropped.

- **Assignments:**
  Final Exam: Open book 3 hr. exam. Approximately about 40 questions divided into 32 numerical and 8 conceptual questions. This breakdown is approximate.
  Midterm: The midterm is an open book which will be given during the discussion period on Thursday. There will be approximately 20-25 questions.
  Quizzes: Quizzes will be given on Tuesdays/Thursdays unless noted otherwise. Approximately **5** questions on each quiz.
  Homework: Homework questions and problems will be selected from the end of chapter problems in the text. Problem numerical parameters are randomized, assigned, submitted, and graded through WebAssign. Homework is due 11:59 pm on the days indicated on the calendar. Homework help is available on Tuesday/Thursday Discussion, office hours by the instructor TR 7:00 pm – 8:00 pm and TA MTWRF (Time TBA). Additional time will be spent by the instructor on homework examples during Discussion.

- **Students Disability Access Center (SDAC):** Students needing the services provided by the Students Disability Access Center (SDAC) will need to be certified by that office. The center is located at 400 Brandon Ave. P.O. Box 800760, Charlottesville, VA 22908-0760, Phone 434-924-5362, Email studenthealth@virginia.edu, Website **student health**

- **University Honor System:** An Honor Offense is defined in the link honor.virginia.edu/overview An honor offense would be any violation of the honor pledge, "On my honor, I pledge that I have neither given nor received help on

this assignment." A pledged assignment means homework, exam, quiz, etc. or any written assignment that requires a grade unless otherwise noted. Your Professor can add to the pledge or document as he see fits. For example, an open book assignment means that you can only use your assigned textbook (digital or notebook versions) and downloaded class slides. You cannot use notes compiled or summarized from other resources. I could change these rules if so desired. If I request you to take an exam with your video unmuted, then you are expected to do so. It could be considered an honor violation if you refused. If you knowingly obtain a copy of a future exam by accident or intent, I will consider that an honor violation. You should report such an incidence to your instructor. I am required to report any suspected violation of the honor code to the honor committee. If you are uncertain about any future action that you might commit, don't hesitate to contact me to ask for advice on whether or not it is an honor violation.

- **Important dates updated**
  - Online Registration opens on SIS Online Registration opens on SIS: Mar 24, 2025 for UVa Graduate students or Mar 27, 2025 for Visiting students.
  - Undergraduate Enrollment Begins (4th/3rd years) Mar 25 2025
  - Undergraduate Enrollment Begins (2nd/1st years) Mar 26 2025
  - For details on Online Registration go to the link Registration and Academic Procedures
  - First Online lecture: Monday May 19
  - No Classes Monday Memorial Day: May 26
  - Midterm: Thursday June 12 1:00 pm
  - Withdrawal Deadline: Full Refund June 17
  - No Classes Juneteenth Observed: June 19
  - Withdrawal Deadline: No Refund June 27
  - Saturday Classes June 28 1:00 to 3:00 pm
  - No Classes Thursday Independence Day: July 4
  - Last discussion session: Tuesday July 8 1:00 pm
  - Last lecture: Wednesday July 9 1:00-2:00 pm
  - Study for final: Thursday July 10 All Day
  - Final exam: Saturday July 12 2:00 - 5:00 pm

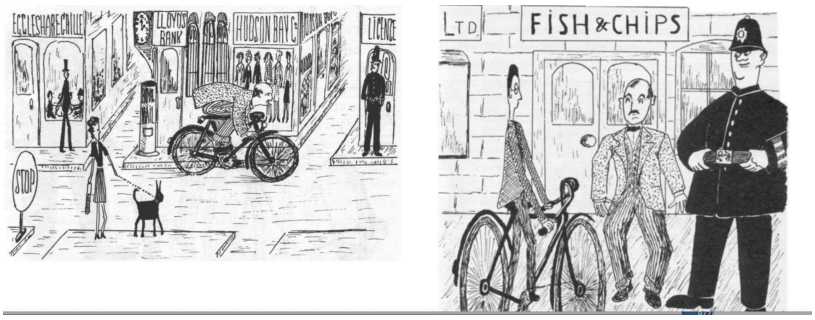
- **Additional Reading Sources**

Modern Physics, Professor Michael Fowler's Notes
Professor Michael Fowler, Emeritus of the University of Virginia, has written a nice set of notes that cover most of the material in this course. It could help you if you read over his notes to obtain a different perspective of the material. These notes are somewhat older, but the subject has not changed. You can find his notes at Professor Fowler Notes

Modern Physics, Kenneth S. Krane, ed. 3
This book contains similar depth of material as Thornton, Rex, and Hood and written with a pedagogical emphasis from Physics Education Research studies. A balanced pedagogical approach examines major concepts first from a historical perspective, then through a modern lens using relevant experimental evidence and discussion of recent developments in the field. Extensive pedagogical tools aid in comprehension, encouraging students to think critically and strengthen their ability to apply conceptual knowledge to practical applications. Numerous exercises and examples reinforce fundamental principles.

Modern Physics for Scientist and Engineers with Modern Physics by Douglas C. Giancoli, ed. 4
One textbook is not always enough. It always helps to have another textbook to look at for subjects which you may find confusing. It helps to have a different viewpoint. I also recommend Physics for Scientist and Engineers with Modern Physics by Douglas C. Giancoli, ed. 4, Vol. 3. You already may have access to it because Volumes I and II are used at the University of Virginia for the first two semesters of the physics series for Engineers, We will cover Chapters 36 to 42 and a little more. It was readily available in the Physics Library.

Mr. Tompkins in Wonderland (Paperback), George Gamow, Cambridge University Press, Reprinted 1994
In his dreams, Mr. Tompkins experiences some of the weird and counterintuitive phenomena of the theories of Relativity and Quantum Mechanics. Gamow uses the ingenious device of lowering the speed of light to 15 km/h and of raising the value of Planck's constant by many orders of magnitude in Mr. Tompkins dreams. As a result the story now embellishes the effects of relativity and quantum effects.



End of syllabus

Lecture	Time	Date	Day-Wk	Calendar PHYS 2620 Updated 2025	Read	Quiz	HW
L1	1:00-1:55	5/19	Mon - 1	Classical Physics Review	1.1-1.6	Due 2:30	**Due 11:59**
L2	2:00-2:55	5/19	Mon - 1	Michelson-Morley exp, Einstein's postulates, Lorentz transformation	2.1-2.4		
D1	**1:00-1:55**	**5/21**	**Tue - 1**	**D1 1:00-1:55 Lorentz Transformation/Questions**			
L3	1:00-1:55	5/21	Wed - 1	Time dilation, Length contraction, simultaneity	2.5		
L4	2:00-2:55	5/21	Wed - 1	Addition of velocities, muon decay, twin paradox	2.6-2.8		
D2	**1:00-2:30**	**5/22**	**Thu – 1**	**D2 1:00-1:55 Relativistic Addition of Velocity/Question QZ01 2:00-2:30**		**QZ01**	
L5	1:00-1:55	5/23	Fri - 1	Spacetime diagrams, invariants, relativistic Doppler Effect	2.9-2.10		
L6	2:00-2:55	5/23	Fri - 1	Relativistic momentum and conservation of momentum	2.11-2.12		**HW01**
	1:00-1:55	5/26	Mon - 2	********Memorial Day No Classes*********			
D3	**1:00-1:55**	**5/27**	**Tue - 2**	**D3: Spacetime and Relativistic Momentum/Questions**			
L7	1:00-1:55	5/28	Wed- 2	Relativistic energy and the conservation of mass-energy	2.11 -2.12		**HW02**
L8	1:00-1:55	5/28	Wed - 2	Computations and binding energy	2.13		
D4	**1:00-2:30**	**5/29**	**Thu - 2**	**D4 Binding Energy/Questions QZ02 2:00-2:30**		**QZ02**	
L9	1:00-1:55	5/30	Fri - 2	X-rays, electron charge, line spectra, and quantization	3.1-3.4		
L10	2:00-2:55	5/28	Fri - 2	Blackbody radiation, photoelectric effect	3.4-3.7		
L11	1:00-1:55	6/2	Mon - 3	Compton Effect, pair production, pair annihilation	3.8-3.9		
L12	2:00-2:55	6/2	Mon - 3	Models of the atom, Rutherford scattering	4.1-4.3		**HW03**
D5	**1:00-1:55**	**6/3**	**Tue - 3**	**D5 Rutherford Scattering/Questions**			
L13	1:00-1:55	6/4	Wed - 3	The Bohr model of the hydrogen atom, correspondence principle	4.3-4.5		
L14	2:00-2:55	6/4	Wed - 3	Successes/failures, x-ray spectra, bremsstrahlung radiation, atomic	4.6-4.7		
D6	**1:00-2:30**	**6/5**	**Thu - 3**	**D6 1:00-1:55 Atomic Model/Questions QZ03 2:00-2:30**		**QZ03**	
L15	1:00-1:55	6/6	Fri - 3	X-ray scattering, de Broglie waves, electron scattering: Quantum I	5.1-5.3		
L16	2:00-2:55	6/6	Fri - 3	Wave Motion, Waves or Particles: Quantum I	5.4-5.5		**HW04**
L17	1:00-1:55	6/9	Mon - 4	Uncertainty Principle Copenhagen, wave functions, particle in a box	5.6-5.8		
L18	2:00-2:55	6/9	Mon - 4	Schrodinger equation, expectation values, and infinite square well	6.1-6.3		
D7	**1:00-1:55**	**6/10**	**Tue - 4**	**D7 Schrodinger Equation/Questions**			
L19	1:00-1:55	6/11	Wed - 4	Time Dependent Schrodinger equation and finite square well	6.4		**HW05**
L20	2:00-2:55	6/11	Wed - 4	2D infinite sq well potential and simple harmonic oscillator	6.5-6.6		
Midterm	**1:00-3:00**	**6/12**	**Thu - 4**	***************Midterm Exam************* 1:00 – 3:00**	**Midterm**	**Due 3:00**	**Midterm**
L21	1:00-1:55	6/13	Fri - 4	Barriers and tunneling	6.7		
L22	2:00-2:55	6/13	Fri - 4	Application/solution of the Schrodinger equation for hydrogen	7.1-7.2		
L23	1:00-1:55	6/16	Mon - 5	Quantum numbers, magnetic effects, normal Zeeman effect	7.3-7.4		
L24	2:00-2:55	6/16	Mon - 5	Intrinsic spin, energy levels, selection rules	7.5-7.6		**HW06**
D8	**1:00-1:55**	**6/17**	**Tue - 5**	**D8 - Intrinsic spin, energy levels, selection rules/Questions**	**7.5-7.6**		
		6/18	**Wed - 5**	***********Juneteenth Day No Classes***********			
D9	**1:00-2:30**	**6/19**	**Thu - 5**	**D9 1:00-1:55 Quantum numbers /Questions QZ04 2:00-2:30**		**QZ04**	
L25	1:00-1:55	6/20	Fri - 5	Atomic structure, Pauli exclusion principle, periodic table	8.1		
L26	2:00-2:55	6/20	Fri - 5	Total angular momentum and the anomalous Zeeman effect	8.2-8.3		
L27	1:00-1:55	6/21	Sat- 5	Maxwell's velocity and speed distribution and equipartition theorem	9.1-9.4		
L28	2:00-2:55	6/21	Sat- 5	Classical and Quantum statistics, molecular bonding, rotational spectra	9.5,10.1		**HW07**
L29	1:00-1:55	6/23	Mon - 6	Neutron and Nuclear Properties	12.1-12.2		
L30	2:00-2:55	6/23	Mon - 6	Binding energy, nuclear forces, and line of stability	12.3-12.5		
D10	**1:00-1:55**	**6/24**	**Tue - 6**	**D10 Nuclear properties/Questions**			
L31	1:00-1:55	6/25	Wed - 6	Nuclear stability and nuclear models	12.5-12.6		
L32	2:00-2:55	6/25	Wed - 6	Radioactive decay	12.6		
D11	**1:00-2:30**	**6/26**	**Thu - 6**	**D11 Radioactive decay/Questions QZ05 2:00-2-30**		**QZ05**	
L33	1:00-1:55	6/27	Fri- 6	Q-values and binding energy in Alpha, Beta, and Gamma decay	12.7		
L34	2:00-2:55	6/27	Fri - 6	Dating artifacts using radioactive decay and nuclear reactions	12.8,13.1		
L35	1:00-1:55	6/30	Mon - 7	Fission and nuclear reactors	13.4-13.5		
L36	2:00-2:55	6/30	Mon - 7	Nuclear chain reactions continued	Notes		
D12	**1:00-2:30**	**7/1**	**Tue - 7**	**D12 1:00-1:55 Fission Reactors/Questions QZ06 2:00-2:30**		**QZ06**	
L37	1:00-1:55	**7/2**	Wed - 7	Fusion and special nuclear applications	13.6-13.7		
L38	2:00-2:55	7/2	Wed - 7	Building the Bomb – the town that never was	Notes		**HW09**
		7/3	**Thu - 7**	************Independence Day - No Classes**************			
L39	1:00-1:55	7/4	Fri - 7	Particle physics, standard model, and fundamental interactions	14.1-14.3		
L40	2:00-2:55	7/4	Fri - 7	Conservation Laws, Quarks, and the Standard Model	14.4-14.7		
L41	1:00-1:55	7/7	Mon - 8	Stellar evolution, dark matter and tenets of general relativity	15.1-15.3		
L42	2:00-2:55	7/7	**Mon - 8**	Test of General Relativity, black holes and gravitational waves	15.4 -15.6		
D13	**1:00-2:30**	**7/8**	**Tue - 8**	**D13 General Relativity/Questions QZ07 2:00-2:30**		**QZ07**	
L43	1:00-1:55	7/9	Wed - 8	Cosmology: Evidence of the big bang and problems with it	16.1-16.3		
L44	2:00-2:55	7/9	Wed - 8	Age of the universe -13.8 billion years	16.4		**HW10**
		7/10	**Thu-8**	**Study for final**			
Final	**2:00-5:00**	**7/11**	**Fri- 8**	************** Final Exam 2:00– 5:00 **************	**Ch. 2 - 16**	**Final**	