NATIONAL INSTITUTE OF PHYSICS

College of Science
University of the Philippines
Diliman, Quezon City

Course	**PHYSICS 73 (ELEMENTARY PHYSICS III)**	
Credit Units	4 units	
Course Description	Thermal physics, relativity, quantum physics	
Prereq, Coreq	Physics 72, None	
References	**UNIVERSITY PHYSICS, 12th Edition by Young and Freedman** PHYSICS for Scientist and Engineers, 4th Edition by Paul Tipler PHYSICS, 5th Edition by David Halliday, Robert Resnick, and Kenneth Krane UNDERSTANDING PHYSICS by Cummings et al SIX IDEAS THAT SHAPED PHYSICS, by Thomas Moore **SPACETIME PHYSICS** by Edwin Taylor and John A. Wheeler (for relativity)	
Course Goal	The course aims to develop the students' physical intuition and ability to systematically solve a wide variety of problems on the fundamentals of thermodynamics, relativity, quantum physics	
Course Requirements	Three (3) Long Examinations	60%
	Final Examination	15%
	Recitation Grade (Recitation Quiz)	15%
	Problem Sets	5%
	Lecture Grade (i.e., Attendance/Quiz)	5%
Teacher	Name: Faculty Room: Consultation Schedule: Email:	

COURSE POLICIES:

1. You are **expected to read** the assigned sections in your book **before** coming to class.
2. The three (3) long exams and the final exam are all departmental and to be taken at the scheduled date and time. The final exam schedule is determined by the college. Schedule conflicts should be consulted with your instructor immediately.
3. You are required to take all three of the long exams. The Physics 73 course group does not use a cancel the lowest exam policy. All three long exams are used to compute your long exam average.
4. A student may be exempted from taking the final exam if **all of the following** conditions are satisfied:
   (1) passed (50% or better) all long exams or, if applicable, the make-up exams.
   (2) has an average exam score of 65% or better
   (3) has a total recitation score that is 75% or better of the maximum possible score
   An exempted student's final exam grade will be the average of the exams.
5. The long problem sets are assigned in parts and should be submitted on the recitation day. Unexcused late submissions will not be accepted.
6. Recitation quizzes missed due to valid reasons will be exempted from the computations of his/her recitation grade. A limit of three excused missed recitation quizzes will be accepted. The rest will be taken to be zero.
7. Physics 73 maintains a ***NO ID, NO EXAM*** policy.
8. Using scientific calculators is allowed during the exams. However, programmable calculators and calculator apps in devices are not allowed.
9. No student should be allowed to go outside during a long exam.
10. In case of a missed exam for a ***valid reason***, the student may take a make-up exam. (Submit your medical certificate **on the following class meeting**.) Any other conflict with the schedule of the exam should be consulted with the instructor immediately. The coverage of

Grading System	
grade(%) ≥ 90.00	**1.0**
90.00 > grade(%) ≥ 85.00	**1.25**
85.00 > grade(%) ≥ 80.00	**1.5**
80.00 > grade(%) ≥ 75.00	**1.75**
75.00 > grade(%) ≥ 70.00	**2.0**
70.00 > grade(%) ≥ 65.00	**2.25**
65.00 > grade(%) ≥ 60.00	**2.5**
60.00 > grade(%) ≥ 55.00	**2.75**
55.00 > grade(%) ≥ 50.00	**3.0**
50.00 > grade(%) ≥ 45.00	**4.0**
45.00 > grade(%)	**5.0**

the make-up exam is the same as that of the missed exam.

11. Students who were not exempted and who missed the final exam will be given a grade of **INC**, provided that they are passing (grade is 50% or higher with the final exam score taken to be zero); otherwise, a grade of **5.00** will be given. Completion period is within one academic year. Completion grade will be computed based on the class record for the enrolled term and the exam score.
12. A grade of **4.00** means conditional and that you may take the removal exam within one academic year.
13. **Attendance will be checked.** As per university rule, a student's absences (excused or unexcused) should not reach **13 meetings**. If 13 absences are accumulated before the dropping deadline, the student is advised to drop; otherwise, a grade of **5.00** will be given. If the 13th absence is incurred after the dropping deadline, the student automatically gets a grade of **5.00**.
14. There is **NO** *FORCED DROP*. The lecturer will only give the student a grade of **DRP** upon completing the dropping process or *Leave of Absence* (LOA) form. Otherwise, a grade of **5.00** is given.
15. The deadline for dropping is on **April 20, 2016 (W)**.
16. The corridors, rooms, entry and exit points of the National Institute of Physics are under CCTV surveillance.
17. **Any form of cheating in examinations or any act of dishonesty in relation to his/her studies, such as plagiarism, shall be subject to disciplinary action.**
18. Unless otherwise specified, assigned readings will be from Young and Freedman 12th ed.
19. Chapter 1, Chapter 1 Exercises, and Answers to the Chapter 1 Exercises of Spacetime Physics can be downloaded from www.eftaylor.com.
20. You should submit 5" × 8" index card containing the following: a 2" × 2" photograph, your name, birthday, course, email address and contact number(s), info on the person to contact in case of emergencies (name, landline, cell number, how you are related), Math 54, Physics 71, and Physics 72 grades. Attach a photocopy of your Form 5 at the back. Submit one copy to your lecturer.

COURSE COVERAGE

Lecture hour no.	Objectives After the discussion and lined up activities, you should be able to:	Topics
1	▪ Explain what is expected of you to get good marks in this class. ▪ Explain the expected role of your teacher. ▪ Explain the expected role of your book. ▪ Explain the expected role of your lecture classes. ▪ Explain the expected role of your recitation classes. ▪ List the materials you will need for this course.	Orientation
	Read: Syllabus, and Young and Freedman, 12th ed. pp. vii- viii	

THERMODYNAMICS

CHAPTER 17: TEMPERATURE AND HEAT

2	▪ Describe how temperature as a physical quantity is measured. ▪ Explain what is thermal equilibrium and how it is determined physically. ▪ Illustrate how the zeroth law is used to define temperature and design temperature scales. ▪ Mathematically and physically describe the relationship of various scales.	Zeroth Law of Thermodynamics Temperature Measurement
	Read: Sec. 17.1, 17.2, 17.3 Exercises 17.1 17.7, 17.13, 17.15	
3	▪ Describe a simple model for the linear and bulk expansion of objects upon absorption of heat. ▪ Calculate for the expansion of solids due to changes in temperature. ▪ Calculate for the thermal stress experienced by solids due to changes in temperature.	Thermal Expansion

	Read: Sec 17.4: Exercises 17.17, 17.22, 17.25, 17.31	
4	▪ Physically describe what heat is. ▪ Mathematically and physically describe specific heat and molar heat capacity. ▪ Solve for heat required/released for a system due to change in temperature. ▪ Solve for heat required/released for a system due to phase change.	Heat Specific Heat and Heat Capacity Calorimetry
	Read: 17.5, 17.6 Exercises: 17.38, 17.42, 17.45, 17.63	
5	▪ Enumerate and differentiate the three ways thermal energy may be transferred. ▪ Describe emissivity and blackbodies. ▪ Solve for heat current in conduction and radiation.	Mechanisms of Heat Transfer
	Read Section 17.7 Exercises 17.65, 17.70, 17.75, 17.77	

CHAPTER 18: THERMAL PROPERTIES OF MATTER

6	▪ Describe what an ideal gas is (i.e. enumerate its properties and provide the defining equation of state). ▪ Compute for a thermodynamic variable given others quantities. ▪ Roughly describe a pV diagram. ▪ Describe a more realistic model of gas. ▪ Cite consequences of Van der Waals equation in the properties of the gas. ▪ Describe some molecular properties of matter.	Ideal Gas equation Van der Waals equation (reading assignment)
	Read Section 18.1, 18.2 Exercises: 18.1, 18.7, 18.14, 18.15, 18.21	
7	▪ Account for the microscopic origins of the various thermodynamic variables. ▪ Enumerate the assumptions of kinetic model of an ideal gas. ▪ Mathematically relate macroscopic variables of an ideal gas with microscopic ones (relate molecular speeds with temperature). ▪ Describe the distribution function of molecular speeds for a given temperature.	Kinetic Theory of Gases
	Read Sec, 18.3, 18.5 Exercises: 18.25, 18.29, 18.33, 18.37, 18.38, 18.46	
8	▪ Calculate the heat capacities of an ideal gas for the various processes. ▪ Illustrate how the heat capacity of a solid is calculated using the equipartition theorem. ▪ Explain the failure of equipartition theorem. ▪ Explain the significance and limitation of equipartition theorem. ▪ Use phase diagrams to describe physical state of substances.	Heat Capacity of Gases Dulong-Petit Law Phases of Matter (reading assignment)
	Read Sec 18.4, 18.6 Exercises 18.41, 18.44, 18.50, 18.52	

Chapter 19: The First Law of Thermodynamics

9	▪ Define a thermodynamic system for a given physical set-up and describe the type of boundary. ▪ Identify the system-environment interactions from the boundary. ▪ Interpret PV diagrams of a thermodynamic process. ▪ Compute the work done using PV diagrams. ▪ Compute the work done for different thermodynamic paths.	Thermodynamic Systems Work Done During Volume Changes Paths Between Thermodynamic States
	Read Sec 19.1, 19.2, 19.3 Exercises 19.1, 19.3, 19.6, 19.41	
10	▪ Explain mathematical and physical significance of internal energy as a state function. ▪ Solve for thermodynamic quantities using the conservation of energy. ▪ Differentiate the following basic thermodynamic processes: isochoric, isobaric, isothermal, adiabatic and a cyclic process. ▪ Write down the first law equations for the said processes.	First Law of Thermodynamics Internal Energy as State Function Thermodynamic Processes
	Read Sec 19.4, 19.5 Exercises 19.9, 19.12, 19.18, 19.19	
11	▪ Differentiate heat capacities of an ideal gas for various processes. ▪ Solve for the change in internal energy, work and heat transferred for the said processes. ▪ Solve for the thermodynamic variables of one state given the thermodynamic variables of another state.	Internal Energy of an Ideal Gas Adiabatic Processes
	Read Sec 19.6, 19.7, 19.8 Exercises 19.23, 19.29, 19.35, 19.38, 19.61	

CHAPTER 20: THE SECOND LAW OF THERMODYNAMICS

12	▪ Describe the operation of an actual engine (esp. Otto engine). ▪ Develop and describe a cyclic process (esp. the Otto process) representing such an engine. ▪ Illustrate per cycle operation of an engine using the Energy Reservoir Model (ERM). ▪ Solve for the efficiency of a heat engine. ▪ Calculate for the power generated and various thermodynamic quantities in a given engine cycle (esp. Otto cycle). ▪ Discuss impossibility of developing a ‘perpetual heat engine’. ▪ State the Heat engine form of the 2nd law and illustrate meaning using ERM and efficiency.	Heat Engines Engine Cycles
	Read Sec 20.1, 20.2, 20.3 Exercises 20.1, 20.3, 20.6 ,20.7, 20.46	
13	▪ Describe the operation of a refrigerator. ▪ Illustrate the ERM of a refrigerator. ▪ Solve for the coefficient of performance of a refrigerator.	Refrigerator

	▪ Solve problems relating heat engine with refrigerator. ▪ Calculate the coefficient of performance if given the efficiency of an engine that is run in reverse as a refrigerator. ▪ State the Refrigerator form of the 2^{nd} law and illustrate meaning using COP and efficiency.	
	Read sec 20.4 Exercises 20.9, 20.10, 20.11, 20.12	
14	▪ Enumerate conditions necessary for a reversible process to take place. ▪ Develop an equivalent reversible process for a given irreversible process. ▪ Illustrate irreversibility in natural processes. ▪ Describe the Carnot cycle (enumerate the processes consisting the cycle as well as illustrate the cycle on a PV diagram for an engine and a refrigerator). ▪ State Carnot's theorem and use it to calculate maximum possible efficiency of a real engine. ▪ Explain how reversible cycles are used to design a substance-independent thermometer scale.	Reversible and Irreversible Processes Carnot Cycle
	Read Sec 20.6 Exercises 20.13, 20.15, 20.17, 20.21, 20.24, Q20.10	
15	▪ Mathematically describe entropy for reversible processes and cite consequences of entropy being a state function. ▪ Solve for entropy changes for various processes: isothermal process, free expansion, inelastic collision, constant pressure process, heat conduction, Carnot cycle. ▪ State 2^{nd} Law in terms of entropy of the universe and explain significance for naturally occurring processes.	Entropy
	Read Sec 20.7 Exercises 20.25, 20.27, 20.29, 20.31, 20.33	
16	▪ Differentiate "useful" from "useless" forms of energy. ▪ Differentiate macroscopic from microscopic interpretation of entropy and illustrate their equivalence as well as use in explaining various physical phenomena. ▪ Describe "order" and "disorder" in terms of the number of available (i.e., accessible) microstates for a given macrostate.	Microscopic Interpretation of Entropy Order and Disorder
	Read Sec 20.8 Exercises 20.34, 20.35, 20.36	

FIRST EXAMINATION	**February 27, 2016 (S), 3:00–5:00 pm**

RELATIVITY

Note: the text to be used here is Spacetime Physics, Taylor and Wheeler, 1^{st} ed.

17	▪ Define an inertial reference frame. ▪ State the Principle of Relativity. ▪ Explain the implications of Einstein's Postulates. ▪ Convert from conventional to natural units c = 1 and vice versa.	Newtonian Relativity Einstein's Postulates Natural Units
	Read Sections 1, 2 and 3 of Spacetime Physics	

	Do Exercises in the handout	
18	▪ Define an event and describe how measurements are taken in an inertial frame. ▪ Define the interval and differentiate it from the Euclidean notion of distance. ▪ Calculate the proper time defined by two events.	Events and Measurements Invariance of the Interval Proper Time
	Read Sections 4 to 5 of Spacetime Physics Exercises from Spacetime Physics: 1, 2, 3	
19	▪ Draw the space-time axis of a given inertial frame and the world lines of all events relative to this inertial frame. ▪ Interpret physical meaning of space-time diagrams. ▪ Relate geometric measurements with relativistic concepts. ▪ Use light cones to determine causal relations between events. ▪ Describe the character of a spacetime interval between two events. ▪ Calculate the proper time along the worldline of a particle.	World Lines Spacetime Diagrams Light Cones Proper Time
	Read Sections 6 and 7 of Spacetime Physics Young and Freedman Exercise 37.2, 37.5, 37.7	
20	▪ Relate measurements of an event in one inertial frame with another inertial frame. ▪ Relate Galilean and Lorentz transformations with the Einstein's Postulates. ▪ Differentiate between quantities that are the same in all reference frames (invariants) from quantities that depend on the reference frame (covariants).	Lorentz Transformation
	Read Section 8 of Spacetime Physics Do Exercise 9, 10, and 11 of Spacetime Physics	
21	▪ Describe synchronization of two clocks relative to inertial observers. ▪ Given a physical situation involving relativistic motion, apply definitions of proper time and proper length to draw qualitative and quantitative conclusions regarding the length, time interval.	Relativity of Simultaneity Length Contraction Time Dilation
	Read Section 8 of Spacetime Physics, Exercise 23 (same content as Young and Freedman Sec 37.2) from Young and Freedman: Ex 37.1	
22	▪ Construct two-observer spacetime diagrams. ▪ Use two-observer spacetime diagrams to identify simultaneous events according to the lab frame, and the rocket frame. ▪ Use two-observer spacetime diagrams to identify events occurring at the same place according to the lab frame, and the rocket frame.	Two-Observer Spacetime Diagrams
	Do Exercise (from Spacetime Physics) 48	
23	. ▪ Given two inertial frames in relative motion, relate the measured velocities in one inertial frame to the measured velocities in the other inertial frame. ▪ Introduce the rapidity. ▪ Given a physical situation involving relativistic motion, apply relativistic Doppler effect to draw qualitative and quantitative conclusions regarding frequency and velocity.	Velocity Transformation Relativistic Doppler Effect

	Spacetime Physics Section 9, Exercise 6, Exercise 80, 83 Young and Freedman Ex 37.15, 37.17, 37.23, 37.25	
24	▪ Calculate the relativistic energy and momentum of a particle given its rest mass and velocity. ▪ Calculate the relativistic energy and momentum of a photon given its velocity, frequency and Planck's constant.	Relativistic Energy-Momentum Planck hypothesis (reading assignment, Ex 72 Spacetime Physics)
	Read Spacetime Physics Sec 10, 11, and 12 pp 101-113, Exercises from Spacetime Physics: 66, 72 Young and Freedman Ex 37.29, 37.30, 37.37, 38.1	
25	▪ Calculate the relativistic energy and momentum of a particle in one reference frame given its measured values in another inertial frame. ▪ Derive the Doppler Shift formulae.	Lorentz Transformation of Energy-Momentum
	Read Spacetime Physics Sec 12. pp 113-121, pp 134-138 Spacetime Physics Exercise 62, 66, 75	
26	▪ Use invariance of mass to relate the energy and momentum of a particle to its rest mass. ▪ Use invariance of mass to relate energy and momentum of a photon. ▪ Relate invariance of mass to invariance of interval. ▪ Calculate the total mass of the system.	Invariance of Mass
	Read Spacetime Physics Sec 13. pp 134-138	
27	▪ Use conservation of energy-momentum and invariance of mass to calculate different quantities involving collisions between particles (i.e., the threshold kinetic energies for a given reaction).	Conservation Laws
	Read Young and Freedman Sec. 44.1 to 44.3 Young and Freedman Ex. 44.1, 44.4, 44.16, 44.21, 44.23	

SECOND EXAMINATION	**April 2, 2016 (S), 3:00–5:00 pm**

QUANTUM PHYSICS

Note: A large part of the material is not in the textbook, but will be based on the lectures.

CHAPTER 38: PHOTONS, ELECTRONS, AND ATOMS

28	▪ Discuss aspects of the photoelectric effect. ▪ Solve for either maximum kinetic energy of the emitted electrons, work function or threshold frequency once the other two are known. ▪ Solve for the energy of a quanta of light given its frequency and vice-versa. ▪ Solve for the momentum of light given its wavelength and vice-versa. ▪ Introduce the Hydrogen Spectrum and deduce the Hydrogen atom energy levels.	Photoelectric Effect Line Spectra Quantization of Light Energy Levels
	Read: 38.1, 38.2, 38.3	

	Ex: 38.1, 38.3, 38.7, 38.15, 38.17	
29	▪ Use conservation of energy to calculate the frequency and wavelength of photons produced during x-ray production. ▪ Use conservation of energy-momentum to derive Compton scattering formula. ▪ Solve for scattering wavelength of light when it collides with matter. ▪ Use the Compton scattering formula to relate the initial wavelength to the final wavelength and scattering angle of the photon .	Bremsstrahlung Compton Scattering
	Read: 38.7, Ex: 38.33, 38.35, 38.39, 38.41 and Ex 70 Chapter 2 of Taylor and Wheeler	
30	▪ Discuss the failure of some classical models of the atom. ▪ Enumerate the postulates in Bohr's model of the atom. ▪ Show how the Bohr model successfully accounted for the observed discrete spectral lines as well as the Rydberg-Ritz relation. ▪ Calculate the allowed orbital speeds and orbital radii of hydrogen atoms.	Bohr Model
	Read: 38.4, 38.5 Ex: 38.22, 38.23, 38.25,38.27	

CHAPTER 39: THE WAVE NATURE OF PARTICLES

31	▪ Discuss the significance of the de Broglie Hypothesis. ▪ Solve for the wavelength and frequency of a particle given its momentum or kinetic energy. ▪ Elaborate on the duality of matter and light and know when one aspect is more useful in explaining observed phenomena. ▪ Recognize the wave function of a free-particle with definite momentum and kinetic energy.	de Broglie Waves Wave-Particle Duality
	Read: 38.9, 39.1 Ex: 39.1, 39.3, 39.5, 39.46, Q39.13	
32	▪ State the uncertainty principle and be able to estimate uncertainties in experiments. ▪ Use the energy-time uncertainty principle to estimate lifetimes and masses. ▪ Use the Heisenberg uncertainty principle to estimate uncertainties in position and momentum.	Uncertainty Principle
	Read: 39.3, lecture notes Ex: 39.19, 39.21 ,39.23, 39.26, Q39.8	
33	▪ Explain what a wave function is and illustrate its significance in determining all physically measurable quantities in a quantum system. ▪ Introduce the Schrodinger Equation and illustrate its significance in describing quantized systems. ▪ Recognize the wave function of a free-particle with definite momentum and kinetic energy.	Wave Functions and the Schrodinger Equation
	Read: Young and Freedman 39.5, Moore Q7 Ex: to be given by the instructor	
34	▪ Solve for the probability of occurrence of a classical event. ▪ Solve for the mean and variance of some classical distributions. ▪ Introduce relevant concepts of basic complex algebra.	Classical Probability Theory, Complex Algebra

	Read: 39.5 and handouts Ex: Young and Freedman 39.31, 39.33, 39.35	
35	▪ Apply relevant concepts of complex algebra in solving expectation values from the wave function. ▪ Solve for the expectation value of various quantum observables (esp. position, momentum, and energy) given the wave function of a quantum system.	Normalization, Expectation Value
	Read: 39.5 and lecture notes	
36	▪ State the superposition principle and relate it to the uncertainty principle in quantum mechanics. ▪ Given a superposition of normalized eigenfunctions of a quantum mechanical observable, calculate the probability that a measurement of the observable yields a specific value.	Superposition of quantum states Eigenfunctions Eigenvalues
	Read: 39.5, lecture notes Ex: 39.37	

CHAPTER 40: QUANTUM MECHANICS

37	▪ Apply the energy eigenfunctions and eigenvalues of an infinite square well to physical problems. ▪ Show the general solution for the time-dependent Schrodinger equation for an infinite square well potential. ▪ Illustrate how a wavefunction evolves over time in this system. ▪ Calculate the wavelengths of photons emitted or absorbed during transitions between energy levels.	Particle in a Box
	Read: 40.1 Ex: Q40.1, Q40.5, 40.1, 40.3, 40.5	
38	▪ Write the appropriate form of the wavefunction of a finite square well for different regions. ▪ Compare the corresponding energies to the infinite square well energies. ▪ Calculate the wavelengths of photons emitted or absorbed during transitions between energy levels.	Finite Square Well
	Read: 40.2 Ex: Q40.13, Q40.14, 40.13, 40.15	
39	▪ Discuss differences in quantum and classical predictions of some unbound systems. ▪ Calculate for the probability of transmitting a quantum particle into classically forbidden regions. ▪ Predict how changing the different physical parameters affect the probability of transmission.	Potential Barrier and Tunneling
	Read: 40.3 Ex: 40.21, 40.22, 40.23	
40	▪ Show the general solution to the time-dependent Schrodinger equation for a harmonic oscillator. ▪ Derive the allowable energies for this system. ▪ Compare the classically allowable energies for a quantum oscillator and a classical oscillator. ▪ Calculate the wavelengths of photons emitted or absorbed during transitions between energy levels.	The Harmonic Oscillator

	Read: 40.4 Ex: Q40.19, 40.27, 40.33	
41	▪ Show how degeneracy arises in quantum systems of more than one dimension. ▪ Generate the possible quantum states of a system by listing down the corresponding quantum numbers. ▪ Solve for the energy levels and energy eigenfunctions of a particle in a 3-D box and determine the degree of degeneracy of each level. ▪ Solve for the energy levels and energy eigenfunctions of a particle in 3-D in a harmonic potential, and determine the degree of degeneracy of each level ▪ Calculate the wavelengths of photons emitted or absorbed during transitions between energy levels.	Schrödinger's Equation in Three Dimensions
	Read: 40.5 Ex: 40.53, 40.54	

CHAPTER 41: ATOMIC STRUCTURE

42	▪ Roughly show how the solution to the time-independent Schrodinger equation for this system leads to quantization of the energy levels and the angular momentum of the electron orbiting the hydrogen nucleus. ▪ State the quantum numbers corresponding to the wavefunctions describing the hydrogen atom. ▪ Determine probabilities of the system having a certain energy and/or angular momentum. ▪ Show electron probability distributions around the nucleus. ▪ Calculate the wavelengths of photons emitted or absorbed during transitions between energy levels.	Hydrogen Atom
	Read: 41.1 Ex: 41.1, 41.3, 41.4, 41.5, 41.6	
43	▪ Discuss the Zeeman effect for the hydrogen atom. ▪ Describe the results of the Stern-Gerlach experiment. ▪ Show how the Stern-Gerlach experiment leads to the need to define the spin of an electron. ▪ Determine how the spin of an electron orbiting the hydrogen nucleus can combine with its orbital angular momentum.	Zeeman Effect and Electron Spin
	Read: 41.2 and 41.3 Ex: 41.14, 41.15, 41.17, 41.19, 41.23	
44	▪ Determine how one can describe many-electron atoms using the Schrodinger equation. ▪ Determine how one can simplify the description of many- electron atoms via the Schrodinger equation. ▪ State the Pauli exclusion principle, and how it is crucial to describing many-electron atoms. ▪ Use the Pauli principle to determine if a candidate many-particle wavefunction is not physically realizable.	Many-Electron Atoms and the Exclusion Principle
	Read: 41.4 Ex: 41.25, 41.27	

THIRD EXAMINATION	**May 14, 2016 (S), 3:00–5:00 pm**

IMPORTANT DATES		**1st Long Exam**	**February 27 (S)**
Start of Classes	January 18 (M)	**1st Make-up Exam**	**March 7 (M)**

2nd Long Exam	**April 2 (S)**
2nd Make-up Exam	**April 11 (M)**
Deadline for Dropping	April 20 (W)
Deadline for Filing LOA	May 2 (M)
3rd Long Exam	**May 14 (S)**
3rd Make-up exam	**May 16 (M)**
End of Classes	May 19 (Th)
Integration Period	May 20 (F)
Final Exam	**May 21 (S 1:45-3:45 PM)**
Removal Exam	June 7 (T)