Syllabus for Physics 0475: Honors Physics I
University of Pittsburgh, Fall 2016

Schedule and Instructors. The class will meet every day (Monday through Friday), 11 AM to 11:50 AM, Thaw Hall 102. Mondays, Wednesdays, and Fridays, the class will be led by the instructor, Professor Arthur Kosowsky (Allen Hall 315, kosowsky@pitt.edu). These classes will be devoted to a mix of lectures, demonstrations, and some interactive activities. Tuesdays and Thursdays are the recitations, led by the teaching assistant Paul Justice (Old Engineering Hall 108D Desk 1, paj42@pitt.edu). Recitations are required, and will be devoted primarily to developing skill in solving problems, and to answering questions about class material. We also may give short quizzes in recitation. Professor Kosowsky will have office hours Monday 2:30 to 4 PM and Thursday 1 PM to 2:30 PM. Other times by appointment if you have schedule conflicts with these times.

Overview. Physics is the fundamental basis for all of science. Observations of planetary motions on the sky during the 16th century led directly to an understanding of the simple laws governing motion of the planets, and the realization that these same laws applied universally. This chain of observation and reasoning during the 17th century culminated with Isaac Newton's formulation of the basic laws of force and motion, which we still use today and will learn in this class. Since then, our knowledge of the basic constituents of the world, the forces between them, and their resulting motions (which we now call "physics") has expanded immensely, but still rest on these universal ideas. Physics formed the first topic for modern science, and helped spark an intellectual revolution which changed the way that people viewed the world.

Physics is one of the most elegant branches of science because of its fundamental simplicity. The details of physics can seem dauntingly complicated, because we express physical concepts and how they relate to each other with mathematics, and the mathematics can be difficult. But all of physics rests on a small number basic concepts which we will learn in this class: forces and motion, conservation of momentum and angular momentum, consevation of energy, waves, entropy. This class will attempt to emphasize this big-picture conceptual unity of physics, even as we work out the particular details.

Our ability to understand physics formed the basis for the industrial revolution and the rise of our modern technological society. Basic physical principles underlie many aspects of modern life: automobiles, airplanes, computers, phones, television, power generation and transmission all operate according to physics. Remarkable devices like GPS receivers and laser scanners are novel applications of physics. Many advances in medical technology have a large physics component, particularly imaging devices like X-rays, CAT scans, and PET scans, and genetic sequencing machines. The cells of our body and our biochemical machinery operate according to physical principles; the application of physics to biology is a relatively young and rich field of current research.

This class will cover the most basic principles of physics, and their application to a wide range of situations, from atoms to galaxies. Aside from learning physics, you will also learn logical thinking, problem solving techniques, and mathematical reasoning. It is no accident that people with physics training are in demand for jobs ranging from engineering to finance to medical research to business management: physics provides valuable skills for any job which requires logical and quantitative thinking.

Textbook. The textbook for the course is *Physics* by Resnick, Halliday, and Krane, 5th edition, Wiley Publishing, 2002. One copy of the textbook will be available on reserve at the Benedum Engineering Library; it may be checked out for two hours to use in the library. The list price of the book is very expensive, but far cheaper used copies are available to buy or rent online.

Assignments and course materials will be posted on the class Blackboard site; sign in at http://courseweb.pitt.edu with your Pitt username and password.

Assignments. You will have one assignment per week, posted on Friday due the following Friday. Each will consist of a number of problems of varying levels of difficulty. For each assignment, some fraction of the problems chosen at random will be graded. Your solutions will be graded both on accuracy of your answers, but also on the process by which you arrive at your answers. Steps for solving problems, and accompanying grading expectations, will be provided near the beginning of class, along with many examples of worked solutions.

You are encouraged to discuss homework problems with fellow students! Even better, form a regular study group with other people in the class. Collaborative learning has been proven to be much more effective

for most physics students than learning in isolation. But you must write up your own original solutions to the assignments. We have no way of knowing whether you are simply copying answers to someone else's homework, but if you do, you will surely do poorly on the exams, which count for the largest portion of your class grade.

Exams. The class will have three exams during the semester, and one cumulative final exam. The dates of these are listed in the calendar below. Midterm exams are scheduled for Fridays starting at 5 PM in the regular classroom, so that you may have as much time as you need to complete the exam. Attendance at exams is required. The only excuses for missing an exam are university-related activities or serious illness. If you are going to miss an exam for one of these two reasons, please let me know as soon as possible. All exams will be open notes and open book, so you do not have to memorize anything. During exams, you may not use any device which is capable of connecting to the internet, including your phone, laptop, or tablet. You may use a calculator but only if it does not connect to the internet. If you normally use your smart phone as a calculator, please invest in a cheap calculator (generally available for less than $10). A few calculators will also be available to share during exams.

Grading. 3 in-class exams, each 15% of the final class grade. 1 final exam, worth 20% of the class grade. Assignments, in total worth 30% of the final class grade. Quizzes in recitation, in total worth 5% of the final class grade. The two lowest assignment scores and the two lowest quiz scores will be dropped from computing your final grade. If your class average is at least 90% you will earn an A for the course, at least 80% for a B, 70% for a C, and 60% for a D. The grade boundaries may be lower than these, depending on the overall class grades.

Prerequisites Math 220 (first-semester calculus) is a prerequisite for this course, and Math 230 (second-semester calculus) is a corequisite. You are expected to be comfortable using derivatives and basic integrals. We will do a brief review of vectors when we begin using them. We will also at times use Taylor series and find the solutions to simple differential equations. These topics are both covered in Math 230, but I will not assume you know this math until after it is covered in Math 230. If you have not taken a high-school level physics class which covers the basics of velocity and acceleration and Newton's Laws, please talk to the instructor about whether you should be in this class or in Physics 174.

Class Etiquette. No cell phones allowed in class – please turn them off and put them away before class starts. Asking questions about class material is strongly encouraged. If you don't understand, it is likely that many other people also do not understand: no question about the material is a "dumb" question. Please do not talk to your neighbors unless it is directly about the class material – and in that case it is probably better to raise your hand and ask a question. During class, a general questions may be asked for group discussion; at this point please DO talk to people seated near you.

Other Class Resources. The Physics Resource Room in 312 Thaw Hall is staffed by physics graduate student teaching assistants from 9 AM to 5 PM on weekdays. These TA's are available to answer questions and help with assignments as needed.

Academic Integrity. Students in this course are expected to comply with University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, or obtain exam materials before the beginning of the exam.

Students with Disabilities. If you have a disability, please speak to the course instructor and to the Disabilities Resources and Services office by the second week of class to make any necessary arrangements to support a successful learning experience, and provide documentation through your disabilities coordinator. The Disabilities Resources office is located in 216 William Pitt Union, 648-7890 (voice or TTD).

Course Schedule

Week 1 (August 29): Introduction. Basic principles, including Newton's Laws, Conservation of Momentum, Conservation of Angular Momentum, Conservation of Energy. Physical quantities and measurement units. Dimensional analysis and examples.

Week 2 (September 5): Velocity and acceleration. Newton's Second Law. Applications to motion in one dimension. NO CLASS September 7: Labor Day.

Week 3 (September 12): Kinetic energy and momentum in one dimension. Conservation of momentum in collisions. Elastic and inelastic collisions. The rocket equation.

Week 4 (September 19): Motion in two dimensions, trajectories, collisions. Air resistance and viscous resistance. EXAM 1: Friday, September 25.

Week 5 (September 26): Static situations and force balance. Tension force, normal force, static friction. Strength of materials.

Week 6 (October 3): Circular motion. Centripetal acceleration. Pendulum motion.

Week 7 (October 10: Newton's Law of Gravitation. Circular and elliptical orbits, Kepler's Laws. Reflex motion, extrasolar planets. Dark matter.

Week 8 (October 17): Rotational motion, moment of inertia, conservation of angular momentum. EXAM 2: Friday, October 21. NO CLASS Monday October 17. CLASS Tuesday October 18, no recitation that day (university on Monday schedule).

Week 9 (October 24): Fluid statics. Hydrostatic equilibrium, buoyancy. Density profile of the atmosphere.

Week 10 (October 31): Harmonic oscillators; examples. Waves and the wave equation, basic solutions.

Week 11 (November 7): Properties of waves: superposition, interference, reflection, refraction. Acoustics; string and wind instruments.

Week 12 (November 14: Zeroth and First Laws of Thermodynamics. Thermal conductivity, thermal expansion. Diffusion equation. EXAM 3: Friday, November 18.

Week of Thanksgiving (November 21): Class on Monday November 16: special topic. NO CLASS Wednesday November 23 or Friday November 25 (Thanksgiving Break).

Week 13 (November 28): Second Law of Thermodynamics and entropy. The connection between entropy and information.

Week 14 (December 5): Kinetic theory. Microscopic basis of thermodynamics.

Week of December 12: FINAL EXAM: Wednesday Dec. 14, 2 PM to 3:50 PM.