

**Physics 0174**  
**Basic Physics for Students of Science and Engineering 1**  
Fall Term 2024 (2251) CRN: 10918

**Lecturer:** Prof. Robert P. Devaty  
211 Allen Hall  
Phone: 412-624-9009  
E-Mail: [devaty@pitt.edu](mailto:devaty@pitt.edu)

**Office Hours:** Allen Hall  
to be determined

**Recitation**

**Instructors:** Dan Luo  
500 Allen Hall, Desk 2  
  
Phone: none  
  
E-Mail: [dal384@pitt.edu](mailto:dal384@pitt.edu)

**Office Hours:**

Tuesday: 10:00 – 11:00 am  
Friday: 11:00 am - noon

**Resource Room:** 304 OEH  
Monday: 1:00 pm - 2:00 pm  
Wednesday: 11:00 am - noon  
Thursday: 10:00 am - 11:00 am  
Friday: 2:00 pm - 3:00 pm

Juhun Kwak  
524 Allen Hall, Desk 2  
Phone: none  
E-Mail: [juk155@pitt.edu](mailto:juk155@pitt.edu)

**Office Hours:**

Wednesdays, 3 – 5 pm

**Resource Room:** Tuesday: 10:00 am – noon  
Wednesday: 10:00 am – noon

**Undergraduate Teaching Assistant:**

Anna Kramer  
304 Old Engineering Hall (red crane in front of building on O'Hara St.)  
**Hours:** Monday: 11:00 am – noon (starting Sept. 9)  
Tuesday and Thursday, 11:30 am – 12:30 pm

E-mail: [agk68@pitt.edu](mailto:agk68@pitt.edu)

**Corequisites:** MATH 0220 or MATH 0235

**Text:** **Fundamentals of Physics** (Twelfth Edition) by David Halliday, Robert Resnick and Jearl Walker, Chapters 1 – 13, 15 – 17. It is important to do the assigned reading **before** the associated lecture.

**Lectures:** The lectures are scheduled for 10:00 – 10:50 am on Mondays and Fridays, 10:00 – 11:50 am on Wednesdays in Room 343 Alumni Hall. The lectures will include class participation via Top Hat and possibly worksheets to be handed in, which will contribute to your grade. The lectures will also include demonstrations of physical phenomena. There is no charge for access to Top Hat. Most likely, the lectures will be recorded and made available on Canvas. They might also broadcast synchronously using Zoom (passcode: 15217), so that you can “attend” the lecture even if you are ill or away on a university-sponsored trip (for example, if you are on a sports team). In addition, links to sets of brief lecture videos and example problems used by Dr. David Nero in his “flipped” version of this course are available on Canvas in case you wish to use them. There will be concept quizzes (reading quizzes) using Achieve to try to identify which aspects of the material you already understand, and which should be emphasized during the lectures. Long uninterrupted lectures are known to not be very effective for learning, so I would like the lectures to be focused and relatively brief episodes interspersed with student activities such as group problem solving, Top Hat questions, etc. Lecture activities will count for credit to the extent that performance can be recorded using Top Hat.

**Homework:** Homework will be assigned using the Achieve on-line system. The homework sets are due at 11:59 pm on Sundays. It is your responsibility to attempt the homework before the recitation section as preparation for the weekly quiz. Homework due dates are typically after the associated recitation quiz. The ability to understand and solve problems is essential for successful performance on quizzes and exams. There will also be short reading check questions on Achieve due before many of the lectures. Your homework scores and reading check scores, automatically compiled by Achieve, will contribute to your grade. To sign up for Achieve, see the instructions on Canvas. The price for Achieve is \$37.99 for one term and \$59.99 for two terms. Most (but not all) Physics 0175 sections use Achieve. The Achieve course ID for this section is: rdt7d7

**Recitation:** Your recitation section provides the opportunity to ask questions and discuss the material in a smaller group. You will also benefit from the alternative viewpoint of the recitation instructor. The format for the recitation depends on your instructor, but might resemble the following:

- Quick review of recent material (5-10 minutes)
- Questions / discussion / problem solving (25-30 minutes) It is highly desirable that most of the recitation period be used for active learning. For example, the recitation instructor can break up the group into smaller groups to do work sheets or guided problems or ask students to work out problems on the board.
- Weekly quiz (10-15 minutes), which will contribute to your grade.

Your recitation grade will be based on the quizzes.

**Canvas Site:** There is a Canvas site associated with this course. It can be accessed through your <http://my.pitt.edu> account. This site will be used to make important announcements and to make materials available such as lecture slides, recorded lectures, exam solutions, announcements, surveys, etc. As mentioned earlier, homework will be handled on-line using Achieve, which you can access through Canvas.

**Examinations:** There will be three 50-minute in-class exams, given during the regular lecture periods on Monday, September 23; Monday, October 28; and Monday, November 18. The comprehensive final examination (likely 25 multiple choice problems) is scheduled by the University for Friday, December 13, from 2:00 – 3:50 pm, at a location to be determined.

**Grading:** Your letter grade will be based on the following percentages:

- |                             |     |
|-----------------------------|-----|
| • In-class Exams            | 40% |
| • Final Exam                | 20% |
| • Homework (Achieve)        | 10% |
| • Recitation Quizzes        | 10% |
| • Reading Quizzes (Achieve) | 10% |
| • Top Hat Lecture Questions | 10% |

Roughly, a standard scale is: A: 90 – 100%, B: 80 – 90 %, C: 70 – 80%, etc., although some fine tuning is likely.

Scores are recorded in the Canvas grade book, as well as in software linked to Canvas, which includes Gradescope, Achieve, and Top Hat.

**Help:** There are many resources available for help in addition to the regular office hours of the instructor and teaching assistants. These include:

- “Resource Room” (312 Thaw Hall): This “room” is staffed by graduate student teaching assistants for the introductory physics and astronomy courses. The hours will be posted on the departmental website. The link is:  
<http://www.physics.pitt.edu/resource-room> .
- UTA Peer Tutor (Anna Kramer) See contact information above.
- Study-Lab (G-1 Gardner Steel Conference Center, 412-648-7920) offers various resources, including peer tutoring: <https://asundergrad.pitt.edu/study-lab>
- A variety of resources available to students are found here:  
<https://pitt.libguides.com/assistanceresources>
- If you wish to hire a private tutor, contact the Physics departmental office, 100 Allen Hall.

## **Academic Integrity**

Students in this course will be expected to comply with the [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, including dictionaries and programmable calculators.

To learn more about Academic Integrity, visit the [Academic Integrity Guide](#) for an overview of the topic. For hands- on practice, complete the [Understanding and Avoiding Plagiarism tutorial](#).

## **Disability Services**

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and [Disability Resources and Services](#) (DRS), 140 William Pitt Union, (412) 648-7890, [drsrecep@pitt.edu](mailto:drsrecep@pitt.edu), (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

## **Equity, Diversity, and Inclusion**

The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University’s Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University’s mission. For more information about policies, procedures, and practices, visit the [Civil Rights & Title IX Compliance web page](#).

I ask that everyone in the class strive to help ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing [titleixcoordinator@pitt.edu](mailto:titleixcoordinator@pitt.edu). Reports can also be [filed online](#). You may also choose to report this to a faculty/staff member; they are required to communicate this to the University’s Office of Diversity and Inclusion. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

## **E-Mail Communication**

Each student is issued a University e-mail address (username@pitt.edu) upon admittance. This e-mail address may be used by the University for official communication with students. Students are expected to read e-mail sent to this account on a regular basis. Failure to read and react to University communications in a timely manner does not absolve the student from knowing and complying with the content of the communications. The University provides an e-mail forwarding service that allows students to read their e-mail via other service providers (e.g., Hotmail, AOL, Yahoo). Students that choose to forward their e-mail from their pitt.edu address to another address do so at their own risk. If e-mail is lost as a result of

forwarding, it does not absolve the student from responding to official communications sent to their University e-mail address.

### **Copyright Notice**

These materials may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials.

See [Library of Congress Copyright Office](#) and the [University Copyright Policy](#).

### **Statement on Classroom Recording**

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

### **Sexual Misconduct, Required Reporting and Title IX**

If you are experiencing sexual assault, sexual harassment, domestic violence, and stalking, please report it to me and I will connect you to University resources to support you.

University faculty and staff members are required to report all instances of sexual misconduct, including harassment and sexual violence to the Office of Civil Rights and Title IX. When a report is made, individuals can expect to be contacted by the Title IX Office with information about support resources and options related to safety, accommodations, process, and policy. I encourage you to use the services and resources that may be most helpful to you.

As your professor, I am required to report any incidents of sexual misconduct that are directly reported to me. You can also report directly to Office of Civil Rights and Title IX: 412-648-7860 (M-F; 8:30am-5:00pm) or via the Pitt Concern Connection at: [Make A Report](#)

If you wish to make a confidential report, Pitt encourages you to reach out to these resources:

- The University Counseling Center: 412-648-7930 (8:30 A.M. TO 5 P.M. M-F) and 412-648-7856 (AFTER BUSINESS HOURS)
- Pittsburgh Action Against Rape (community resource): 1-866-363-7273 (24/7)

If you have an immediate safety concern, please contact the University of Pittsburgh Police, 412-624-2121

Any form of sexual harassment or violence will not be excused or tolerated at the University of Pittsburgh.

For additional information, please visit the [full syllabus statement](#) on the Office of Diversity, Equity, and Inclusion webpage.

### **Your Well-being Matters**

College can be an exciting and challenging time for students. Taking time to maintain your well-being and seek appropriate support can help you achieve your goals and lead a fulfilling life. It can be helpful to remember that we all benefit from assistance and guidance at times, and there are many resources available to support your well-being while you are at Pitt. You are encouraged to visit [Thrive@Pitt](#) to learn more about well-being and the many campus resources available to help you thrive.

If you or anyone you know experiences overwhelming academic stress, persistent difficult feelings and/or challenging life events, you are strongly encouraged to seek support. In addition to reaching out to friends

and loved ones, consider connecting with a faculty member you trust for assistance connecting to helpful resources.

The [University Counseling Center](#) is also here for you. You can call 412-648-7930 at any time to connect with a clinician. If you or someone you know is feeling suicidal, please call the University Counseling Center at any time at 412-648-7930. You can also contact Resolve Crisis Network at 888-796-8226. If the situation is life threatening, call Pitt Police at 412-624-2121 or dial 911.

## **Learning Goals:**

### **Overall**

- State, both in words and equations, the laws of classical mechanics. Explain their meanings and give examples of situations to which they apply.
- Recognize and effectively make use of the terminology associated with classical mechanics.
- Work with various representations of physical laws, including conceptual, graphical, and equations, and be able to transfer between representations as necessary to analyze and solve specific problems/situations.
- Use relevant mathematics, including vector algebra, vector calculus, systems of linear equations, etc., as a tool to express the relevant laws of physics and apply them to specific situations.
- Describe a problem and a strategy to solve it conceptually.
- Analyze a problem conceptually and break up a complex problem or situation into simpler parts.
- Apply relevant physical laws and mathematics to formulate a strategy and then solve a given problem (towards the goal of recognizing the relevance of the material covered in this course to other fields in science and engineering, and to everyday life, and be able to take advantage of your acquired skills to analyze situations and apply the laws of physics to gain insight and make predictions).
- Check numerical results that the values make sense conceptually (having a feel for the numbers) and have the correct units and significant figures.

### **Topic/Chapter Specific**

The following list was developed by a departmental committee. I have classified them according to the relevant chapters in the textbook, the 12<sup>th</sup> edition of Halliday, Resnick and Walker. I will include learning objectives in the lecture slides. Note that the book lists learning objectives at the beginning of each chapter and section.

#### **Chapter 1: Measurement**

#### **Chapter 2: Motion Along a Straight Line**

- Make a graph of the instantaneous displacement, velocity, and/or acceleration of a system based on a description of the motion or using another graph.
- Apply the equations of 1-D kinematics to one or more objects with constant acceleration. Examples include free-fall, two objects that meet one another, and an object that has different constant acceleration at different times.

#### **Chapter 3: Vectors (will be covered before Chapter 2)**

- Add or subtract two or more vectors. (Relative velocity problems are an application of this category.)
- Find the dot product or cross product of two vectors.

#### **Chapter 4: Motion in Two and Three Dimensions**

- Describe the behavior of an object undergoing projectile motion based on the equations of 2-D kinematics.

#### Chapter 5: Force and Motion I

- Apply a conceptual understanding of Newton's first and third law.
- Draw a free-body diagram and solve for an unknown force or acceleration of a system under the influence of two or more forces.

#### Chapter 6: Force and Motion II

- Calculate the force of static/kinetic friction or the coefficient of friction.
- Calculate the drag force or terminal speed of an object.
- Identify the centripetal force that acts on a system undergoing circular motion.

#### Chapter 7: Kinetic Energy and Work

- Find the work done by a force in cases where integration is not required (perhaps by inspecting a graph of force versus displacement). Alternately, find the force given work and displacement.
- Calculate the average power provided by a force.

#### Chapter 8: Potential Energy and Conservation of Energy

- Apply conservation of mechanical energy to describe the motion of a system.
- Use the work-energy theorem to identify the amount of mechanical energy that has been lost.

#### Chapter 9: Center of Mass and Linear Momentum

- Calculate the average force or impulse during a collision or series of collisions.
- Apply conservation of momentum to an explosion or collision. Be able to identify whether a collision is elastic, inelastic, or completely inelastic.
- Answer a conceptual question about momentum, rockets, and/or the motion of the center of mass.

#### Chapter 10: Rotation

- Apply kinematics to a rotating system. Be able to convert between the tangential values of  $s$ ,  $v$ ,  $a$  and  $\theta$ ,  $\omega$ , using the radius  $r$ .
- Distinguish between angular, tangential, and centripetal acceleration.

#### Chapter 11: Rolling, Torque, and Angular Momentum

- Determine the net torque acting on a body about a given axis and/or the angular acceleration of that body. Doing so may require the use of one or more moments of inertia.
- Calculate the motion of a rolling object using torques and/or energy conservation. "Rolling" could be caused by a cord wrapped around the object, like in a yo-yo.
- Find the rotational kinetic energy of an object.

- Identify whether angular momentum is or is not conserved, and if appropriate, apply conservation of angular momentum to a rotating system.

Chapter 12: Equilibrium and Elasticity (Equilibrium will be covered with Chapter 11, Elasticity with Chapter 15)

- Use the definition of static equilibrium to solve for one or more unknown forces or torques acting on a system.

Chapter 13: Gravitation (will be covered after Chapter 15)

- Apply energy conservation to a system with gravity to describe the motion of an object in a case where  $U = mg$  is not an appropriate assumption.
- Use Kepler's laws of planetary motion to describe the motion of a planet, moon, or satellite about its parent body.

Chapter 15: Oscillations

- Apply the concepts of stress, strain, and ultimate strength to a deformed object.
- Calculate a spring constant given the elastic properties of a material.
- Identify when a system (spring, simple pendulum, or physical pendulum) is undergoing simple harmonic motion, and find the amplitude, period, frequency, angular frequency, phase angle, displacement, velocity, and/or acceleration.
- Apply conservation of mechanical energy to a simple harmonic oscillator (spring, simple pendulum, or physical pendulum). Damping may be involved.

Chapter 16: Waves I

- Determine the amplitude, period, frequency, angular frequency, wave number, wavelength, and/or propagation speed of a transverse traveling wave. If the wave is on a string, be able to calculate the propagation speed using the tension and linear density.
- Predict the result of interference between two waves with identical amplitude and frequency. Specifically, be able to identify constructive, destructive, and intermediate interference - determining the amplitude and/or phase difference in the latter case.

Chapter 17: Waves II

- Identify the resonant frequencies and/or harmonics of a string or open/closed pipe.
- Apply the equation for the Doppler effect to determine the shift in frequency caused by motion.

**Physics 0174 (CRN 10918)**  
**Basic Physics for Students of Science and Engineering 1**  
**2251, Fall 2024**

R.P. Devaty

Lectures: Mo, Fr 10:00 – 10:50 am, Wed 10:00 – 11:50 am

343 Alumni Hall

Recitation Instructors: to be determined

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Aug. 25	26 Lect 1	27	28 Lect 2	329	30 Lect 3	31
Sept. 1	2 Labor Day	3	4 Lect 4	5	6 Lect 5 Add/Drop ends	7
8	9 Lect 6	10	11 Lect 7	12	13 Lect 8 Extended Add/Drop Ends	14
15	16 Lect 9	17	18 Lect 10	19	20 Lect 11	21
22	23 Exam 1	24	25 Lect 12	26	27 Lec 13	28
29	30 Lect 14	1	2 Lect 15	3 Rosh Hashanah	4 Lect 16	5
Oct. 6	7 Lect 17	8	9 Lect 18	10	11 Lect 19	12 Yom Kippur
13 Fall Break	14	15	16 Lect 20	17	18 Lect 21	19 PJAS Cryogenics
20	21 Lect 22	22	23 Lect 23	24	25 Lect 24 Final Exam Conflict Form Submission Deadline; Monitored Withdrawal Deadline	26
27	28 Exam 2	29	30 Lect 25	31	1 Lect 26	2
Nov. 3 Daylight Savings Time ends	4 Lect 27	5 Election Day - Remote	6 Lect 28	7	8 Lect 29	9
10	11 Lect 30	12	13 Lect 31	14	15 Lect 32	16
17	18 Exam 3	19	20 Lect 33	21	22 Lect 34	23
24 Thanksgiving Break	25	26	27	28 Thanksgiving	29	30
Dec. 1	2 Lect 35	3	4 Lect 36	5	6 Lect 37	7
8	9 Lect 38	10 Last Class Day	11	12	13 Final Exam 2:00 – 3:50 pm	14
15	16	17	18	19 Grades Due 11:59 pm	20	21



Recitations:

10919: W 1:00-1:50 pm 105 Allen, Dan Luo

19494: W 2:00-2:50 pm 105 Allen, Julun Kwak

10920: H 11:00-11:50 am 105 Allen, Julun Kwak

16703: H 12:00-12:50 pm 105 Allen, Julun Kwak

10921: H 1:00-1:50 pm 105 Allen (13) Dan Luo

Lectures: Week (50-minute periods)

**Week 1** (4): Aug. 26, 28, 30

- Lecture 1: Introduction
- Lecture 2 (2): Measurements (units, dimensions, length, time, mass, significant figures); Scalars, Vectors: representations, components, unit vectors, addition and subtraction
- Lecture 3: Vectors: scalar and cross products; Kinematic variables: position, displacement, velocity and acceleration (average and instantaneous)
- Recitation: Belonging Intervention

**Week 2** (3): Sept. 4, 6

- Lecture 4 (2): 1-D Motion, including free fall, use of graphical methods
- Lecture 5: Motion in 2 and 3 dimensions (definitions of kinematic quantities as vectors)
- Recitation Quiz 1: Vector Addition (Vectors)

**Week 3** (4): Sept. 9, 11, 13

- HW 1: Vectors and 1-D Motion
- Lecture 6: Projectile Motion
- Lecture 7 (2): Uniform Circular Motion, Relative Motion in 1 and 2 Dimensions (relative velocity)
- Lecture 8: Forces and Mass, Newton's First Law
- Recitation Quiz 2: 1D (and possibly 2D) Kinematics

**Week 4** (4): Sept 16, 18, 20

- HW 2: Kinematics
- Lecture 9: Newton's Second Law; Catalog of Forces: Gravity, Tension, Contact (normal) force
- Lecture 10 (2): Applications of Newton's Second Law
- Lecture 11: Friction and Applications
- Recitation Quiz 3: Forces (not including friction)

**Week 5** (4): Sept. 23, 25, 27

- **Exam 1**: September 23: Vectors, 1D and 2D Kinematics, Forces (not friction)
- HW 3: Forces I
- Lecture 12: Friction and Applications

- Lecture 13 (2): Applications of Newton's Laws to Circular Motion (Centripetal Force); Drag Force
- Recitation: No quiz

**Week 6** (4): Sept. 30; Oct. 2, 4

- Lecture 14: Work Done by a Force (gravity, spring, variable force)
- Lecture 15 (2): Work; Kinetic Energy; Work-Energy Theorem with Applications; Power
- Lecture 16:
- Recitation Quiz 4: Friction and Centripetal Force

**Week 7** (4): Oct. 7, 9, 11

- HW 4: Forces II
- Lecture 17: Applications of Work-Energy Theorem; Power
- Lecture 18 (2): Conservative Forces and Potential Energy: gravity, spring; Conservation of Total Mechanical Energy with Applications; Potential Energy Diagrams; Generalization of Energy Conservation; Conservation of Energy: Applications; Generalization of Energy Conservation
- Lecture 19: Applications/Examples of Energy Conservation
- Recitation Quiz 5: Work

**Week 8** (3): Oct. 16 18

- HW 5: Work
- Lecture 20 (2): Center of Mass; Linear Momentum; Impulse; Impulse Momentum Theorem; Conservation of Total Linear Momentum with examples
- Lecture 21: Collision Problems: 1D
- Recitation Quiz 6: Energy Conservation

**Week 9** (4): Oct. 21, 23, 25

- HW 6: Energy
- Lecture 22: Collision Problems: 2D
- Lecture 23 (2): Angular Kinematic Variables; Rotational Motion for constant angular acceleration; relations between regular and rotational kinematic variables; moment of inertia; rotational kinetic energy; examples
- Lecture 24: Torque; Newton's Second Law rewritten; Equilibrium problems
- Recitation Quiz 7: Momentum Conservation

**Week 10** (4): Oct. 28, 30; Nov. 1

- **Exam 2**: October 28: Friction, Work, Energy, Momentum
- HW 7: Momentum
- Lecture 25 (2): Rotational Dynamics: nonequilibrium problems; conservation of energy
- Lecture 26: Rolling: forces, kinetic energy, torque
- Recitation: No quiz

**Week 11** (4): Nov. 4, 6, 8

- HW 8: Rotation 1

- Lecture 27: Angular momentum; conservation of total angular momentum; applications
- Lecture 28 (2): Conservation of total angular momentum: Applications; Elasticity; Simple Harmonic Motion; Various Examples
- Lecture 29: Simple Harmonic Motion; Various Examples: mass and spring, simple pendulum, torsional oscillator, etc; energy, relation to uniform circular motion
- Recitation Quiz 8: Rotational Kinematics and Torque (also Angular Momentum, if ready)

**Week 12 (4):** Nov. 11, 13, 15

- HW 9: Rotation II
- Lecture 30: Simple harmonic motion: Examples
- Lecture 31 (2): Damped oscillations; forced oscillations and resonance; Newton's Law of Gravitation; superposition; gravity near the surface of the earth
- Lecture 32: Gravity inside the earth; gravitational potential energy
- Recitation Quiz 9: Simple Harmonic Motion
- 

**Week 13 (4):** Nov. 18, 20, 22

- **Exam 3**: November 18: Rotational Kinematics, Torque, Angular Momentum, Simple Harmonic Motion
- HW 10: Elasticity, Oscillations
- Lecture 33: Gravity: orbits of satellites; Kepler's Laws
- Lecture 34: Waves: Description of a transverse wave; wave speed and the medium
- Recitation: No quiz
- Next week is Thanksgiving Break.

**Week 14 (4):** Dec. 2, 4, 6

- Lecture 35: Waves: wave speed, power, Interference
- Lecture 36: Waves: Standing waves and resonance
- Lecture 37 (2): Sound: Description, traveling waves, intensity, interference
- HW 11: Gravity and Waves
- Recitation Quiz 10: Gravity and Waves

**Week 14 (1):** Dec. 9

- Lecture 38: Waves: Sound: Beats; Doppler Effect; Review
- **Final Exam**: Friday, December 13, 2:00 – 3:50 pm