PHYS 121: University Physics I: Mechanics

Term: Fall 2026
Credits: 4.0
Meeting Times & Location: Multiple sections. Your section's days, time, room, and instructor are listed in AlkimiHub and on your Canvas course page.
Modality: In-Person

Instructor Information

- **Course Coordinator:** Dr. Megan Hollander (Assistant Teaching Professor of Physics)
- **Section Instructors:** Listed for each section in AlkimiHub. Your section instructor's office hours and office are posted in your Canvas course page.
- **Email:** mhollander@university.alkimi.ai
- **Office:** Meridian Science Center 414
- **Coordinator Office Hours:**
  - Monday & Wednesday: 3:00–4:30 p.m. (In person, Meridian Science Center 414)
  - Tuesday: 11:00 a.m.–12:00 p.m. (Virtual via Zoom; link posted in Canvas)
  - Also available by appointment.

Course Description

Calculus-based mechanics for science and engineering majors: vectors, kinematics, Newton's laws, energy and momentum conservation, rotational dynamics, gravitation, and oscillations, with a weekly three-hour laboratory. PHYS 121 is the first course in the calculus-based introductory physics sequence for students majoring in physics, engineering, chemistry, and mathematics. The course develops rigorous analytical and vector methods to model mechanical phenomena, emphasizing differential and integral calculus in formulating physical laws. Key areas of investigation include translational and rotational kinematics and dynamics, work-energy principles, impulse and linear momentum conservation, systems of particles, rotational inertia, Newtonian gravitation, and harmonic oscillations.

Prerequisites

MATH 140 (prior or concurrent).

Measurable Student Learning Outcomes

Upon successful completion of PHYS 121, students will be able to:

1. **Analyze Kinematics Using Calculus:** Differentiate and integrate vector equations of motion to describe position, velocity, and acceleration in one, two, and three dimensions.
2. **Apply Newton's Laws with Differential Equations:** Formulate and solve equations of motion for particles experiencing constant, time-dependent, velocity-dependent (drag), and position-dependent forces.

3. **Apply Conservation of Energy and Momentum:** Evaluate conservative force fields, potential energy functions, work-energy theorems, and systems of interacting particles via linear momentum conservation.
4. **Analyze Rotational Dynamics and Angular Momentum:** Compute moments of inertia using volume integration and parallel axis theorem, and solve coupled rotational-translational dynamic systems using torque and angular momentum conservation.
5. **Evaluate Gravitational Fields and Orbital Mechanics:** Apply Newton's law of universal gravitation and Kepler's laws to derive orbital trajectories, escape velocities, and gravitational potential energy.
6. **Model Oscillatory Systems and Resonance:** Derive and solve differential equations for simple harmonic oscillators, damped oscillators, and driven resonant systems.

Required Course Materials & Approximate Costs

1. **Halliday, David, Robert Resnick, and Jearl Walker. *Fundamentals of Physics*. 12th ed., Wiley, 2021.** Approx. $65 for digital access; approx. $140 for print purchase.
2. **OpenStax University Physics, Volume 1. Free digital access at openstax.org.** Free.
3. **Scientific calculator with trigonometric functions (graphing calculators and phone apps prohibited on exams).** Approx. $15 to $25.
4. **Total estimated cost:** $15 to $165.

Generative AI Policy (AI Level 2: AI Permitted with Disclosure for Specified Tasks)

In accordance with Alkimi University Academic Policies (Student Handbook §5.8), PHYS 121 operates under **AI Level 2**.

- **What is permitted:** You may use Alkimi or other approved AI tools to review vector calculus concepts, generate practice integration problems for variable-force mechanics, and verify non-graded practice problems during study sessions.
- **What is prohibited:** You may not use AI tools to solve assigned weekly problem sets, generate lab notebook responses, or access any generative tools during quizzes, midterms, or the common final examination.
- **Disclosure:** For any homework or project where AI assistance was utilized for conceptual study, include an AI statement specifying the prompt, the platform used, and how you independently validated the physics.

Grading Components and Weights

- **Midterm Exam 1:** 15% (In class during week 5 (week of September 21))
- **Midterm Exam 2:** 15% (In class during week 10 (week of October 26))
- **Weekly Problem Sets:** 20% (Due Fridays at 11:59 p.m. in Canvas (weeks 2–13; lowest dropped))
- **Laboratory Investigations & Reports:** 20% (Laboratory reports submitted in Canvas; sections meet weekly)
- **Weekly Quizzes:** 5% (Canvas pre-lecture quizzes due Tuesdays at 11:59 p.m.; lowest two dropped)
- **Common Final Examination:** 25% (Thursday, December 17, 2026, 7:00–9:00 p.m.)

Grading Scale (Alkimi University Standard)

- **A:** 93–100% | **A-:** 90–92%
- **B+:** 87–89% | **B:** 83–86% | **B-:** 80–82%
- **C+:** 77–79% | **C:** 73–76% | **C-:** 70–72%
- **D+:** 67–69% | **D:** 60–66% | **F:** Below 60%
- **Extra credit:** No extra credit assignments are offered in coordinated multi-section courses.

Course Schedule (Fall 2026)

All sections follow this common weekly schedule. Section meeting days vary, so dates are shown by week; your section instructor posts exact class dates in Canvas.

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 1	Aug 26–Aug 28	**Measurement, Vectors, and One-Dimensional Kinematics:** Unit systems, dimensional analysis, vector algebra, instantaneous velocity, acceleration as derivatives, and motion with variable acceleration. *Reading: Halliday Ch. 1–2*	*First day of classes: Wed Aug 26.*
Week 2	Aug 31–Sep 4	**Two- and Three-Dimensional Kinematics:** Position vectors, trajectory curvature, projectile motion with calculus, uniform and non-uniform circular motion, and relative motion. *Reading: Halliday Ch. 3–4*	*Wed Sep 2: Add/section change deadline.*
Week 3	Sep 8–Sep 11	**Newton's Laws and Free-Body Formulations:** Inertial reference frames, Newton's three laws, mass versus weight, contact forces, and differential equations of particle motion. *Reading: Halliday Ch. 5*	*Mon Sep 7: Labor Day (no classes). Wed Sep 9: Census date (last day to drop without a W).*
Week 4	Sep 14–Sep 18	**Friction, Drag, and Circular Dynamics:** Static and kinetic friction models, fluid drag forces, terminal velocity derivation via separation of variables, and centripetal force. *Reading: Halliday Ch. 6*	—
Week 5	Sep 21–Sep 25	**Work and Kinetic Energy & Midterm Exam 1:** Work done by constant and varying forces, scalar dot product, line integrals, work-kinetic energy theorem; Midterm Exam 1 in class. *Reading: Halliday Ch. 7*	**Midterm Exam 1 (in class this week).**
Week 6	Sep 28–Oct 2	**Potential Energy and Conservation of Energy:** Conservative forces, gradient of potential energy, mechanical energy conservation, energy diagrams, and nonconservative work. *Reading: Halliday Ch. 8*	—
Week 7	Oct 5–Oct 9	**Center of Mass and Linear Momentum:** Continuous center of mass integrals, momentum conservation in particle systems, impulse, and variable-mass systems (rocket equation). *Reading: Halliday Ch. 9.1–9.4*	—
Week 8	Oct 14–Oct 16	**Collisions and Conservation Laws:** Elastic and inelastic collisions in one and two dimensions, center of mass frame of reference, and ballistic pendulums. *Reading: Halliday Ch. 9.5–9.9*	*Oct 12–Oct 13: Fall break (no classes). Fri Oct 16: Midterm grades due.*
Week 9	Oct 19–Oct 23	**Rotational Kinematics and Moment of Inertia:** Angular quantities, rotational kinetic energy, moments of inertia via volume integrals, and parallel-axis theorem. *Reading: Halliday Ch. 10*	—
Week 10	Oct 26–Oct 30	**Torque, Angular Momentum, and Dynamics & Midterm Exam 2:** Vector cross product, torque, Newton's second law for rotation, angular momentum conservation, and gyroscopic precession; Midterm Exam 2 in class. *Reading: Halliday Ch. 11*	**Midterm Exam 2 (in class this week).**
Week 11	Nov 2–Nov 6	**Equilibrium and Elasticity:** Conditions for static equilibrium, rigid body stability, stress, strain, Young's modulus, shear modulus, and bulk modulus. *Reading: Halliday Ch. 12*	*Fri Nov 6: Last day to withdraw (W) or elect Pass/No Pass.*
Week 12	Nov 9–Nov 13	**Gravitation and Planetary Motion:** Newton's law of universal gravitation, shell theorem, gravitational potential energy, Kepler's laws, and satellite orbits. *Reading: Halliday Ch. 13*	—
Week 13	Nov 16–Nov 20	**Fluid Mechanics:** Hydrostatic pressure, Pascal's principle, Archimedes' principle, continuity equation, Bernoulli's equation, and laminar flow. *Reading: Halliday Ch. 14*	—
Week 14	Nov 23–Nov 24	**Simple Harmonic Motion:** Linear restoring forces, differential equation of simple harmonic motion, simple and physical	*Nov 25–Nov 27: Thanksgiving break (no classes).*

Week	Dates	Topics & Readings	Assignments & Deadlines
		pendulums, and energy in simple harmonic motion. *Reading: Halliday Ch. 15.1–15.3*	
Week 15	Nov 30–Dec 4	**Damped and Driven Oscillations:** Damped harmonic oscillators, underdamping, critical damping, overdamping, forced oscillations, resonance, and Q-factor. *Reading: Halliday Ch. 15.4–15.8*	—
Week 16	Dec 7–Dec 9	**Mechanical Waves and Common Final Review:** Traveling wave characteristics, wave speed on strings, wave equation, superposition, standing waves, and comprehensive review. *Reading: Halliday Ch. 16 & Review*	*Wed Dec 9: Last day of classes. Thu Dec 10: Reading Day.*
Finals	Dec 17	**Common Final Examination:** Thursday, December 17, 2026, 7:00–9:00 p.m., rooms by section, posted in Canvas.	Comprehensive examination covering all mechanics topics, vectors, conservation laws, and oscillations.

Course Policies

Attendance Policy

Consistent attendance and active participation across lecture and laboratory meetings are essential for mastering calculus-based physics. If you must miss a class due to illness or sanctioned university travel, inform Dr. Hollander and your section instructor promptly. More than two unexcused lab absences results in an administrative failure. Students who miss the first two class meetings without notifying the instructor may be dropped. Students may miss class for religious observance without penalty if they notify the instructor in writing within the first two weeks of the semester (by Wednesday, September 9, 2026). Absences for university-sponsored activities (athletics, performances, conferences) are excused with a letter from the sponsoring office at least one week in advance.

Late Work Policy

Homework problem sets submitted within 24 hours of the Friday deadline receive a 20% deduction; no problem sets are accepted after 24 hours because detailed solutions are released. Pre-lecture quizzes close strictly at the deadline, though the two lowest quiz grades are dropped automatically.

Final Exam Policy

The final examination (Thursday, December 17, 2026, 7:00–9:00 p.m.) is a common exam for all sections, scheduled by the University Registrar and can't be moved without the Dean's written approval (Faculty Handbook §5.5). A student with three or more final exams on the same calendar day may reschedule one of them. Requests go to the instructor of the middle exam by the last day of classes. For this term, send the request by Wednesday, December 9, 2026 (Student Handbook §6.4).

Academic Integrity

Alkimi University is an academic community devoted to rigorous scholarship, open intellectual inquiry, and uncompromising ethical conduct. All students are subject to the regulations of the Alkimi University Academic Integrity Policy. Academic dishonesty—including plagiarism, cheating on examinations, unauthorized collaboration, fabrication of empirical data, and unauthorized submission of academic work generated by artificial intelligence—undermines the integrity of the university and carries severe disciplinary sanctions. Sanctions range from a failing grade on an assignment or exam to an administrative course failure recorded as an 'XF' on the official transcript, academic suspension, or expulsion. Suspected violations are formally investigated and resolved through the Office of Academic Integrity in accordance with Faculty Handbook §6. For detailed information, consult the Office of Academic Integrity, Lovell Hall 315, (555) 555-0163, integrity@university.alkimi.ai.

Accessibility Services

Alkimi University is committed to providing equitable educational access and reasonable accommodations for all students with documented disabilities, including physical, sensory, psychological, learning, and chronic health conditions. Students requesting academic accommodations must formally register with the Office of Accessibility Services, Harlan Hall 204, (555) 555-0155, access@university.alkimi.ai. Once approved, students will receive an official Faculty Accommodation Letter detailing approved accommodations. Students should present this letter to the instructor as early in the semester as possible, and at least one week prior to any exam or assignment requiring accommodation. Accommodations cannot be applied retroactively.

Student Wellness and Mental Health

Your physical health, psychological well-being, and mental health are essential to your academic success. If you experience heightened stress, anxiety, depressive symptoms, personal trauma, or academic burnout, free, confidential counseling and medical care are available through the Hollis Health & Counseling Center, located in the Hollis Center. Routine appointments are available Monday–Friday 8:00 a.m.–6:00 p.m. and Saturday 10:00 a.m.–2:00 p.m. during the semester by calling (555) 555-0190 or emailing health@university.alkimi.ai. Urgent, 24/7 crisis psychological counseling is accessible immediately at (555) 555-0199.

Campus Student Support Services

- **Academic Advising Center:** Lovell Hall 101 | (555) 555-0158 | advising@university.alkimi.ai
- **Writing Center:** Whitcombe Library 3rd Floor | Free consultations on papers, reports, and research projects at any stage.
- **Whitcombe Library:** Whitcombe Library, Main Floor | (555) 555-0170 | askalibrarian@university.alkimi.ai
- **Hollis Health & Counseling Center:** Hollis Center | (555) 555-0190 | 24/7 Counseling Line: (555) 555-0199 | health@university.alkimi.ai
- **Physics Tutoring Center:** Drop-in peer tutoring and problem-solving consultations Monday through Thursday from 2:00 to 6:00 p.m.