Term Information

Effective Term	Spring 2023
Previous Value	*Autumn 2022*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

We are requesting for Physics 1270 to be approved as New GE (Natural Sciences category).

What is the rationale for the proposed change(s)?

Physics 1270 is a newly approved course. It covers the same content as Physics 1250 (which has been approved as a Natural Sciences GE) but is specific to Physics, Engineering Physics, and Astronomy & Astrophysics majors. Our students will take Physics 1270 instead of 1250 to satisfy the GE requirement and prerequisite requirements for their major.

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

Physics, Engineering Physics, and Astronomy & Astrophysics majors will take Physics 1270 instead of Physics 1250 to satisfy the Natural Sciences GE requirement and prerequisite requirements for their major.

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Physics
Fiscal Unit/Academic Org	Physics - D0684
College/Academic Group	Arts and Sciences
Level/Career	Undergraduate
Course Number/Catalog	1270
Course Title	Classical Mechanics, Conservation Laws, and Special Relativity for Majors
Transcript Abbreviation	Mech,Energy,Rltvty
Course Description	Calculus-based introduction to classical physics. In depth study of classical mechanics including Newton's laws, conservation laws, and introduction to special relativity. For students majoring in Astronomy & Astrophysics, Engineering Physics, or Physics.
Semester Credit Hours/Units	Fixed: 5

Offering Information

Length Of Course	14 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Laboratory, Lecture, Recitation
Grade Roster Component	Recitation
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never

Campus of Offering Columbus, Lima, Mansfield, Marion, Newark, Wooster

Previous Value *Columbus*

Prerequisites and Exclusions

Prerequisites/Corequisites Concur: Math 1141, 1151, 1154, 1156, 1161, 1181H, or 4181H or above; and enrollment in Astronomy & Astrophysics major, Engineering Physics major or pre-major, or Physics major.

Exclusions

Electronically Enforced Yes

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code 40.0801

Subsidy Level Baccalaureate Course

Intended Rank Freshman, Sophomore

Requirement/Elective Designation

Required for this unit's degrees, majors, and/or minors

General Education course:

Natural Sciences

Previous Value

Required for this unit's degrees, majors, and/or minors

Course Details

Course goals or learning objectives/outcomes

- Students understand the basic facts, principles, theories and methods of modern science.
- Students understand key events in the development of science and recognize that science is an evolving body of knowledge.
- Students describe the interdependence of scientific and technological developments.
- Students recognize social and philosophical implications of scientific discoveries and understand the potential of science and technology to address problems of the contemporary world.
- Student develop skills in problem solving and analysis that establish a foundation for further study in the area of physics.

Content Topic List

- Mechanics: Units, ID Motion, Acceleration, Projectile Motion, Forces, Free-Body Diagrams, Coupled Forces, Friction, Momentum, Collisions, Center of Mass, Circular Motion, Gravity, Rotation, Angular Momentum, Torque
- Conservation Laws: conservation of momentum, force, work, power, and energy
- Relativity and Relativistic Mechanics: Principle of Relativity, the nature of time, the metric equation, Lorentz Contraction, four-momentum

Sought Concurrence No

Attachments

- Physics_1270_GE_Justification_Draft_v2.pdf: GE Foundations request document

  (Other Supporting Documentation. Owner: Thaler,Lindsey Nicole)
- Phy1270Syllabus_2022_v8.pdf: Syllabus

  (Syllabus. Owner: Thaler,Lindsey Nicole)

Comments

- As requested, GE specific information has been added to pages 3 and 4 of the updated syllabus (attached). Thank you. *(by Thaler,Lindsey Nicole on 10/12/2022 08:27 AM)*
- Please see Panel feedback e-mail sent 09/20/22. *(by Cody,Emily Kathryn on 09/20/2022 02:08 PM)*
- \- The effective term selected is AU22. However, since the NMS panel is not meeting over the Summer & thus cannot review the course, please make the effective term SP23.

  \- Please check off new GE Natural Science category.

  \- We recommend you do not request the legacy GE category since only a tiny number of students might need this course under the old GE. For those students (if any), an exception could be made through the petition process.

  -Please check off all campuses since under GEN, all campuses need to be able to have access to a GE course. (Or provide a rationale for OAA that explains why that should not be the case for Physics 1270.) *(by Vankeerbergen,Bernadette Chantal on 06/06/2022 02:19 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Thaler,Lindsey Nicole	06/06/2022 11:29 AM	Submitted for Approval
Approved	Humanic,Thomas John	06/06/2022 11:34 AM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	06/06/2022 02:20 PM	College Approval
Submitted	Thaler,Lindsey Nicole	06/06/2022 03:33 PM	Submitted for Approval
Approved	Humanic,Thomas John	06/06/2022 04:07 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	08/31/2022 01:04 PM	College Approval
Revision Requested	Cody,Emily Kathryn	09/20/2022 02:08 PM	ASCCAO Approval
Submitted	Thaler,Lindsey Nicole	10/12/2022 08:28 AM	Submitted for Approval
Approved	Humanic,Thomas John	10/12/2022 09:19 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	10/12/2022 11:59 AM	College Approval
Pending Approval	Cody,Emily Kathryn Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	10/12/2022 11:59 AM	ASCCAO Approval

Syllabus:
Physics 1270
Classical Mechanics, Conservation Laws, and Special Relativity

Autumn 2022

Course Information

- **Course times:**
  Lecture: Monday, Wednesday, Friday at 3:00-3:55pm
  Lab: Tuesday 3:00-5:05pm
  Recitation: Thursdays 3:00-3:55pm or 4:10-5:05pm
- **Credit hours:** 5
- **Mode of delivery:** In person.
- **This course satisfies a Natural Sciences GE requirement**

Instructor

- **Name:** Brian L Winer
- **Email:** winer.12@osu.edu
- **Office location:** PRB 3042
- **Office hours:** Monday 7:30-8:30pm (Zoom), Thursday 1:30-2:30pm (in-person)
- **Preferred means of communication:**
  - My preferred method of communication for questions is **email.**
  - My class-wide communications will be sent through the Announcements tool in CarmenCanvas. Please check your notification preferences (go.osu.edu/canvas-notifications) to be sure you receive these messages.

Course Prerequisites

Concurrent with: Math 1141, Math 1151, 1154, 1156, 1161, 1181H, or 4181H or above. Enrollment in Astronomy & Astrophysics major, Engineering Physics major or pre-major, or Physics major. Or instructor permission

Course Description

Calculus-based introduction to classical physics. In depth study of classical mechanics including Newton's laws, conservation laws, and introduction to special relativity. For students majoring in Astronomy & Astrophysics, Engineering Physics, or Physics.

Learning Outcomes

1. Successful students are able to explain basic facts, principles, theories and methods of modern natural sciences; and describe and analyze the process of scientific inquiry.
2. Successful students are able to identify how key events in the development of science contribute to the ongoing and changing nature of scientific knowledge and methods.
3. Successful students are able to employ the processes of science through exploration, discovery, and collaboration to interact directly with the natural world when feasible, using appropriate tools, models, and analysis of data.
4. Successful students are able to analyze the inter-dependence and potential impacts of scientific and technological developments.
5. Successful students are able to evaluate social and ethical implications of natural scientific discoveries.
6. Successful students are able to critically evaluate and responsibly use information from the natural sciences.
7. Student develop skills in problem solving and analysis that establish a foundation for further study in the area of physics.
8. Students will develop hard skills including developing a foundation in classical mechanics and special relativity. The classic mechanics will include an understanding of Newtonian Mechanics, Conservation Laws, and how to apply these concepts to make predictions of physical systems. The introduction to Special Relativity will include the foundational principles, the basic implications, such as length contraction and time dilation, and the mathematical tools for describing the theory, such as Lorentz Transformations.
9. Students will develop soft skills, such a good study habits, ability to work well in a group, and good problem-solving skills.

Physics 1270 is a Natural Sciences General Education (GE)

Goals of the Natural Sciences GE:

1. Successful students will engage in theoretical and empirical study within the natural sciences while gaining an appreciation of the modern principles, theories, methods, and modes of inquiry used generally across the natural sciences.
2. Successful students will discern the relationship between the theoretical and applied sciences while appreciating the implications of scientific discoveries and the potential impacts of science and technology.

Expected Learning Outcomes of the Natural Sciences GE:

Successful students are able to:

1.1. Explain basic facts, principles, theories, and methods of modern natural sciences, and describe and analyze the process of scientific inquiry.
1.2. Identify how key events in the development of science contribute to the ongoing and changing nature of scientific knowledge and methods.
1.3. Employ the processes of science through exploration, discovery, and collaboration to interact directly with the natural world when feasible, using appropriate tools, models, and analysis of data.
2.1. Analyze the inter-dependence and potential impacts of scientific and technological developments.
2.2. Evaluate social and ethical implications of natural scientific discoveries.
2.3. Critically evaluate and responsibly use information from the natural sciences.

The course explores three "great ideas" that shaped our view of the physical world: conservation laws constrain interactions, the laws of physics are universal, and the laws of physics are frame-independent. There is a short textbook for each of these concepts. In the course we use these ideas to explore a wide range of physical phenomena. We define quantities that are used to describe and analyze physical processes. As topics and new ideas are introduced, we explore the historical experiments and scientists that pointed the way toward these great ideas.

How Physics 1270 meets the above goals and expected learning outcomes:

As an introductory physics course, one of the most important learning objectives is good problem-solving technique. In Physics 1270, we emphasis that learning how to approach a problem is as important as obtaining the correct answer. (Note: our rubric for "Show Work" problems reinforces this point, see more below).

The three "Great Ideas" that we explore in this course emerged at different times. Newton is primarily responsible for the concept of physical laws being universal. We discuss his contribution through his three laws of motion and his law of gravity. We point out that for the first time, the same physical law is being used to describe an object falling on the earth's surface and the motion of the planets in the heavens. The behavior of celestial objects is no longer mysterious or sacred but instead subject to the same laws of nature as terrestrial processes.

To explore the processes of sciences through exploration, discovery, and collaboration, students will participate in weekly laboratory session allows them to see and test physical laws. The lab exercises are designed to explore the topics being discussed in lecture and those being explored in homework. Students prepare for lab by performing reading ahead of lab and in some cases a short calculation of expected results might occur. In lab students work in small groups, 2-3 students. The groups setup and make measurements with the equipment.

Physics, like most sciences, builds upon itself. Concepts learned in the first week are reinforced and integrated with concepts throughout the semester. As students add concepts and techniques to their "toolbox" more complex examples can be analyzed and more "real world" examples can be considered. For instance, we start with conservation of momentum, which provides a tool for analyzing simple interactions between objects.

This class explores social and ethical implications of scientific discoveries in the 17th, 18th, and 19th centuries. The topics of the course, other than special relativity, are primarily scientific discoveries that took place in the 17th and 18th century. Special Relativity is a product of the early 20th century. The earlier concepts coincide with the scientific revolution of the time and the period of the Enlightenment. We discuss how Newton's Laws of Motion overturned thousands of years of philosophical thought from philosophers such as Aristotle. The scientific development of this time was a precursor to the Industrial Revolution of the 19th century.

Lastly, students in Physics 1270 will be able to critically evaluate and responsibly use information from the natural sciences by learning the problem solving and critical analysis components of this course. We use rubrics that focus on process rather than the final result. Part of that process is critically evaluating the answer. We teach the students how to make order of magnitude calculations. When answers are determined, we ask whether the approximate size of the answer makes sense. Does the algebraic sign make sense? Is the answer physically possible? Does the answer have the correct units? We have the students consider limiting cases, where a physical parameter is taken to an extreme, then asks whether their answer has the behavior expected. All of these exercises attempt to get the student to think carefully about the answer they have derived and consider whether it is consistent with what they expect and know about the physical world. These approaches are discussed on the very first day of class and repeated throughout the semester in homework, group work, and lab.

How This Course Works

Mode of delivery: This course expected to be delivered in person. If University policy requires a change in the delivery method due to COVID restrictions, then arrangements will be made to deliver instruction via Zoom or equivalent. If you have University sponsored events that might cause you to miss a one or more classes, discuss it with me *as soon as possible.*

Pace of activities: This course is divided into approximately **weekly modules.** These modules are presented on CARMEN (carmen.osu.edu) and typically include pre-lecture review, problems solved in small groups during recitation, homework, and laboratory exercises.

Credit hours and work expectations: This is a 5 credit-hour course that includes lecture, laboratory, and recitation components. According to Ohio State bylaws on instruction (go.osu.edu/credit hours), students should expect 6 hours of in-class work per week (this includes 3 hours of lecture, 2 hours of lab, and 1 hour of recitation) in addition to 9 hours outside of class (reading and assignment preparation, for example) to receive a grade of [C] average.

Attendance and participation requirements:

- **Class Attendance**: **required**
  Lecture participation will involve discussion of topics and answering TopHat questions presented during lecture.
- **Laboratory**: **required**
  Laboratory participation involves attending the laboratory meeting where you will be conducting experiments and analyzing data from those experiments.
- **Recitation: required**
  Recitation will involve working in small groups to solve complex problems.
- **Office hours**: **optional**
  Office hours are optional and are attended as needed by students.

Commented [ODEE1]: To Instructor: Customize this section with information about your particular course context.

These expectations can vary widely between courses, depending on whether the participation is synchronous (live) or asynchronous (CarmenCanvas only), so your guidance in the syllabus can be crucial.

Course Materials, Fees and Technologies

Required Materials and/or Technologies

- **Text**: Six Ideas that Shaped Physics, 3rd Edition by Thomas Moore, Units C, N, R.
- **Laboratory Workbook**: Will be provided.

Required Equipment

- **Webcam:** Required for Zoom office hours. Built-in or external webcam, fully installed and tested
- **Microphone:** Required for Zoom office hours. Built-in laptop or tablet mic or external microphone

CarmenCanvas Access

You will need to use BuckeyePass (buckeyepass.osu.edu) multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you do each of the following:

- Register multiple devices in case something happens to your primary device. Visit the BuckeyePass - Adding a Device (go.osu.edu/add-device) help article for step-by-step instructions.
- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.
- Install the Duo Mobile application (go.osu.edu/install-duo) on all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357 (HELP) and IT support staff will work out a solution with you.

Technology Skills Needed for This Course

- Basic computer and web-browsing skills
- Navigating CarmenCanvas (go.osu.edu/canvasstudent)
- CarmenZoom virtual meetings (go.osu.edu/zoom-meetings)

Other Skills Needed for This Course

- Basic knowledge of calculus (such as would be obtained in Math 1151, 1141, or 1181H).

Technology Support

For help with your password, university email, CarmenCanvas, or any other technology issues, questions or requests, contact the IT Service Desk, which offers 24-hour support, seven days a week.

- **Self Service and Chat**: go.osu.edu/it
- **Phone:** 614-688-4357 (HELP)
- **Email:** servicedesk@osu.edu

Grading and Faculty Response

How Your Grade is Calculated

Assignment Category	Points
Lecture Preparation (Quiz)	10%
Lecture Attendance/Participation	10%
Laboratory Experiments and Exercises	20%
Group Work in Recitation	10%
Homework	20%
Unit Exams (three total)	30% (10% each)

For each component, other than the Unit Exams, the lowest grade of component will be dropped. For example, there will be fourteen homework assignments. The lowest score will be dropped and the other thirteen will count for 20% of your total grade.

See Course Schedule for due dates.

Descriptions of Major Course Assignments

Lecture participation (10%): Lecture is where we will review concepts and put them to work in practice problems. Participation is assessed based on participation in TopHat questions in class or small group assignments. The purpose of the TopHat questions is for students to engage with the material so the participation grade is entirely based on you responding to the TopHat questions, not whether or not you respond correctly.

Lab work (20%): See physics happening in front of your eyes, and build skill in experimental methods. Activities for credit will be checked by TA prior to departing lab.

Group work (10%): Build your problem-solving muscles by working on harder problems in groups, in an environment where you can phone a friend for help (i.e., talk with your expert TA!).

Lecture Preparation (10%): Prior to the Lectures each week, there will be a reading assignment from the book with a simple CARMEN "quiz" to provide responses, either a simple multiple choice or a short written response. These will be due on Mondays at 1pm and can be accessed through the CARMEN Assignments or Modules tabs. The material covered by the reading assignment is the reading for that current week. The exception is the first reading assignment, which will cover the material from this syllabus in addition to the Week 2 reading. You can take the reading assignment quiz twice, and we'll keep the higher score.

Homework (20%): Weekly homework can be accessed through the CARMEN Assignments or Modules tabs. These will normally be due Friday nights at 11:59pm.

Unit exams (30%): There will be three unit exams after the completion of each book unit (C = conservation, N = Newtonian Mechanics, and R = Relativity). Each exam is worth 10% of the grade for a total of 30%. These exams will be completed during a lecture session.

Academic integrity and collaboration: Your submitted assignments should be your own original work. We do encourage students to help each other understand the material. However, the bulk of each assignment should be - unambiguously - each student's own work. Science is a collaborative field and so working together is important, but one must be careful to distinguish one's own contributions from those of others.

Regrades

If you think there's been a mistake in the grading of any individual assignment, please fill out and submit the regrade form via Carmen within two weeks of getting your graded assignment back. The process is described in the "Useful links for course information" Module on Carmen.

What to do if you miss an assignment or get sick

Drop policy: One week's worth of each element (except for the final exam) will be dropped, no questions asked. This can be either a missed assignment (e.g., if you get sick), or your lowest grade (if you complete all assignments in the category). We will not count the first week's lecture participation toward the final lecture participation grade in acknowledgment of the flux in enrollment, in addition to a week's worth of other lectures.

Late work: Late Hand-in homework will be accepted after the assignment deadline for 50% credit if it's in within 24 hours of the deadline.

Late/incomplete work beyond the drop policy: If you have an issue that causes you to miss assignments beyond this, please contact your instructor (Prof. Winer in the 3 pm section, Prof. Peter in the 4:10 pm section) ASAP, as soon as the issue arises.

What to do if you feel like you are falling behind

Reach out! Contact an instructor or TA, and we can help you develop strategies to help. We also strongly recommend that you form study groups--interacting with other humans helps solidify concepts. Everyone in the group brings a different perspective and skillset to the table.

Grading Scale

93–100: A
90–92.9: A-
87–89.9: B+
83–86.9: B
80–82.9: B-
77–79.9: C+
73–76.9: C
70–72.9: C-
67–69.9: D+
60–66.9: D
Below 60: E

Instructor Feedback and Response Time

- **Preferred contact method:** If you have a question, please contact me first through my Ohio State email address. I will reply to emails within **24 hours on days when class is in session at the university**.
- **Class announcements:** I will send all important class-wide messages through the Announcements tool in CarmenCanvas. Please check your notification preferences (go.osu.edu/canvas-notifications) to ensure you receive these messages.
- **Grading and feedback:** For large weekly assignments, you can generally expect feedback within **seven days**.

Commented [ODEE2]: To instructor: The text in this section is provided as a suggestion. Fill in with your own policies.

Other Course Policies

Discussion and Communication Guidelines

The following are my expectations for how we should communicate as a class. Above all, please remember to be respectful and thoughtful.

- **Writing style**: While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. A more conversational tone is fine for non-academic topics.
- **Tone and civility**: Let's maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm doesn't always come across to others.

Commented [ODEE3]: To Instructor: The text in this section is provided as a suggestion. Fill in with your own policies.

These expectations are appropriate for classes where discussion occurs in CarmenCanvas.

Suggested language for Zoom-based classes can be found under discussion expectations (go.osu.edu/odee-syllabus-discussion) in the ODEE syllabus template article.

Academic Integrity Policy

See Descriptions of Major Course Assignments for specific guidelines about collaboration and academic integrity in the context of this online class.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's Code of Student Conduct (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)
- Eight Cardinal Rules of Academic Integrity (go.osu.edu/cardinal-rules)

Copyright for Instructional Materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on Title IX

All students and employees at Ohio State have the right to work and learn in an environment free from harassment and discrimination based on sex or gender, and the university can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.

If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options on Ohio State's Title IX website (titleix.osu.edu) or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin and disability. For more information, visit the OIE website (equity.osu.edu) or email equity@osu.edu.

Commitment to a Diverse and Inclusive Learning Environment

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

Your Mental Health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. No matter where you are engaged in distance learning, The Ohio State University's Student Life Counseling and Consultation Service (CCS) is here to support you. If you find yourself feeling isolated, anxious or overwhelmed, ondemand mental health resources (go.osu.edu/ccsondemand) are available. You can reach an on-call counselor when CCS is closed at 614- 292-5766**. 24-hour emergency help** is available through the National Suicide Prevention Lifeline website (suicidepreventionlifeline.org) or by calling 1-800-273-8255(TALK). The Ohio State Wellness app (go.osu.edu/wellnessapp) is also a great resource.

Accessibility Accommodations for Students with Disabilities

Requesting Accommodations

The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services (SLDS). After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

Disability Services Contact Information

- Phone: 614-292-3307
- Website: slds.osu.edu
- Email: slds@osu.edu
- In person: Baker Hall 098, 113 W. 12th Avenue

Accessibility of Course Technology

This online course requires use of CarmenCanvas (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- CarmenCanvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)
- Collaborative course tools

Course Schedule

The following is a preliminary schedule. If adjustments are needed during the semester, as revised schedule will be posted to the Carmen page and a notice will be made using the Announcements tool in CarmenCanvas. Refer to the CarmenCanvas course for up-to-date due dates.

This course uses the textbook series *Six Ideas that Shaped Physics*, 3rd Edition by Thomas Moore. This book series consists of the following book units:

C = Conservation Laws (*Conservation Laws Constrain Interactions*) – covered in 1270
N = Newton's Laws (*The Laws of Physics are Universal*) – covered in 1270
R = Relativity (*The Laws of Physics are Frame-Dependent*) – covered in 1270
E = Electromagnetism (Electric and Magnetic Fields are Unified) – covered in 1271
Q = Quantum Mechanics (*Particles Behave like Waves*) – covered in 1271
T – Thermodynamics (*Some Processes Are Irreversible*) – covered in 1271

Below lists the chapters that will be covered each week. The letter indicates the book unit above and the number indicates the chapter. For example "C1" is the first chapter from Unit C.

Week 1 Lab topic: Introduction

C1: Introduction to Interactions
C2: Vectors

Week 2 (No class Monday), Lab topic: Vectors & Forces

C3: Interactions Transfer Momentum
C4: Particles and Systems
Lecture Preparation Quick #1 due Monday
Homework assignment #1 due Friday

Week 3 Lab topic: Momentum

C5: Applying Momentum Conservation
C6: Introduction to Energy
C7: Some Potential Energy Functions
Lecture Preparation Quick #2 due Monday
Quiz #1 (Thursday in recitation)
Homework assignment #2 due Friday

Week 4 Lab topic: Momentum & Energy

C8: Force and Energy
C9: Rotational Energy
C10: Thermal Energy
Lecture Preparation Quick #3 due Monday
Homework assignment #3 due Friday

Week 5 Lab topic: Rotational Energy

C11: Energy in Bonds

C12: Power, Collisions
C13: Angular Momentum
Lecture Preparation Quick #1 due Monday
Quiz #2 (Thursday in recitation)
Homework assignment #4 due Friday

Week 6 Lab topic: Angular momentum
C14: Conservation of Angular Momentum
Unit C Review
N1: Newton's Laws
Unit Exam #1 (unit C) this week in lecture
Lecture Preparation Quick #5 due Monday
Homework assignment #5 due Friday

Week 7 Lab topic: Motion
N2: Vector Calculus
N3: Forces from Motion
N4: Motion from Forces
Lecture Preparation Quick #6 due Monday
Quiz #3 (Thursday in recitation)
Homework assignment #6 due Friday

Week 8 Lab topic: Friction
N5: Statics
N6: Linearly Constrained Motion
N7: Coupled Objects
Lecture Preparation Quick #7 due Monday
Homework assignment #7 due Friday

Week 9 Lab topic: Forces & Motion
N8: Circularly Constrained Motion
N9: Noninertial Reference Frames
N10: Projectile Motion
Lecture Preparation Quick #8 due Monday
Quiz #4 (Thursday in recitation)
Homework assignment #8 due Friday

Week 10 Lab topic: Projectiles
N11: Oscillatory Motion
N12: Introduction to Orbits
Lecture Preparation Quick #9 due Monday
Homework assignment #9 due Friday

Week 11 Lab topic: Oscillations
N13: Planetary Motion
Unit N Review

R1: The Principle of Relativity
Unit Exam #2 (Unit N) this week in lecture
Lecture Preparation Quick #10 due Monday
Homework assignment #10 due Friday

Week 12 Lab topic: Gravity & Light
R2: Synchronizing Clocks
R3: The Nature of Time
Lecture Preparation Quick #11 due Monday
Quiz #5 (Thursday in recitation)
Homework assignment #11 due Friday

Week 13 Lab Topic: Special Adventures
R4: The Metric Equation
R5: Proper Time
R6: Coordinate Transformation
Lecture Preparation Quick #12 due Monday
Quiz #6 (Thursday in recitation)
Homework assignment #12 due Friday

Week 14 No Lab
R6: Coordinate Transformation (cont.)
R7: Lorentz Contraction
Lecture Preparation Quick #13 due Monday
Homework assignment #13 due Friday

Week 15 Lab Topic: Time & Space
R8: The Cosmic Speed Limit
R9: Four-Momentum
R10: Conservation of Four-Momentum
Lecture Preparation Quick #14 due Monday
Quiz #7 (Thursday in recitation)
Homework assignment #14 due Friday

Week 16 No Lab
Unit R Review and Contingency
Unit Exam #3 (Unit R) this week in lecture

1. **Expected Learning Outcome 1.1: Successful students are able to explain basic facts, principles, theories and methods of modern natural sciences; describe and analyze the process of scientific inquiry.** Please link this ELO to the course goals and topics and indicate *specific* activities/assignments through which it will be met. *(50-700 words)*

The course explores three "great ideas" that shaped our view of the physical world: conservation laws constrain interactions, the laws of physics are universal, and the laws of physics are frame-independent. There is a short textbook for each of these concepts. In the course we use these ideas to explore a wide range of physical phenomena. We define quantities that are used to describe and analyze physical processes. As topics and new ideas are introduced, we explore the historical experiments and scientists that pointed the way toward these great ideas.

As an introductory physics course, one of the most important learning objectives is good problem-solving technique. We emphasis that learning how to approach a problem is as important as obtaining the correct answer. (Note: our rubric for "Show Work" problems reinforces this point, see more below.) Early in the course we introduce this approach as a multi-step process: *Conceptualize, Categorize, Analyze, and Finalize*. This approach is used for examples performed in lecture and the students practice this approach on homework, in recitation, and in lab.

A typical week in the course consists of multiple components: i) preparatory reading ahead of lecture and a short quiz to test their reading; ii) lecture (3 days a week); iii) recitation (1 day); iv) a laboratory session; vi) online homework; vii) hand-in homework; viii) essential skills exercises. The online homework and hand-in homework allow the students to apply what is being learned to specific cases. The hand-in homework is a "Show Work" style that the students must demonstrate all their reasoning and work that leads to the final answer. The homework comes as a worksheet formatted according to the problem-solving approach. The grading rubric, explicitly shown on the worksheet, is heavily weighted toward the approach used and minimally weighted toward obtaining the correct final answer. In recitation, students work in groups on more complex problems. Modern physics (and science in general) is a collaborative endeavor and the group work helps teach this point. The laboratory session allows a hands-on experience of observing, measuring, and analyzing a physical process. Students see that the physicals law don't just work on paper, they work in practice. This also provides an opportunity to experience experimental uncertainty. While the algebraic solution provides the answer as we would expect it, our measurements might vary due to our approach and limitations of our equipment. [393 Words]

2. **Expected Learning Outcome 1.2: Successful students are able to identify how key events in the development of science contribute to the ongoing and changing nature of scientific knowledge and methods.** Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. *(50-700 words)*

The three "Great Ideas" that we explore in this course emerged at different times. Newton is primarily responsible for the concept of physical laws being universal. We discuss his contribution through his three laws of motion and his law of gravity. We point out that for the first time, the same physical law is being used to describe an object falling on the earth's surface and the motion of the planets in the heavens. The behavior of celestial objects is no longer mysterious or sacred but instead subject to the same laws of nature as terrestrial processes.

Conservation laws emerged more slowly and initially from experimental observations. Why specific quantities (e.g. energy and momentum) were conserved was explained at a fundamental level by a mathematician Emmy Noether in the early 20^{th} century. When we begin the unit on conservation laws, we introduced Noether's Theorem, which states for every symmetry in a physical system there is a conserved quantity. While introducing Noether's important contribution, we talk about the difficulties and biases that she faced as a woman of Jewish decent in the world of academia.

The idea that the laws of physics are frame independent lead directly to the topic of Special Relativity developed by Albert Einstein. This revolutionary idea fundamentally changed our view of space and time. This topic lends itself to discussion of specific experimental observations that led to the theory and tests that occurred after. We explore these experiments and their implications. In addition, we make a connection to our everyday experiences. For example, GPS system rely on Einstein's theory of relativity – the blue dot on your phone uses his theory to determine its location. These connections are brought out through discussion in lecture, reading assignments, homework problems and recitation group work. [294 words]

3. **Expected Learning Outcome 1.3: Successful students are able to employ the processes of science through exploration, discovery, and collaboration to interact directly with the natural world when feasible, using appropriate tools, models, and analysis of data.** Please explain the 1-credit hour equivalent experiential component included in the course: e.g., traditional lab, course-based research experiences, directed observations, or simulations. Please note that students are expected to analyze data and report on outcomes as part of this experiential component. *(50-1000 words)*

The weekly laboratory session allows students to see and test physical laws. The lab exercises are designed to explore the topics being discussed in lecture and those being explored in homework. Students prepare for lab by performing reading ahead of lab and in some cases a short calculation of expected results might occur. In lab students work in small groups, 2-3 students. The groups setup and make measurements with the equipment. They will become familiar with basic experimental tools and measurement devices (e.g. force meters). The data collected is analyzed in a lab book. In some labs the students will be solving for an unknown quantity (e.g. the mass of a particular object) and in other labs the students will be comparing the experimental results to a prediction based on physical laws being studied at the time. When evaluating the results in their report, students are expected to describe experimental uncertainties and errors that impact their results. The lab instructor grades the laboratory exercises and results of the students. This grading is primarily focused on technique and student thought process rather than accuracy of results. [185 words]

4. **Expected Learning Outcome 2.1: Successful students are able to analyze the inter-dependence and potential impacts of scientific and technological developments.** Please link this ELO to the course goals and topics and indicate *specific* activities/assignments through which it will be met. *(50-700 words)*

Physics, like most sciences, builds upon itself. Concepts learned in the first week are reinforced and integrated with concepts throughout the semester. As students add concepts and techniques to their “toolbox” more complex examples can be analyzed and more “real world” examples can be considered. For instance, we start with conservation of momentum, which provides a tool for analyzing simple interactions between objects. More complex interactions require conservation of angular momentum and conservation of energy. Students see how integrating these three conservation laws leads to a deeper understanding of physical motion and interactions. Once Newton’s Universal Law of Gravity is introduced, we can use it, along with conservation laws, to understand planetary motion and derive Kepler’s Laws (empirical) from first principles.

Problems that appear on homework, in lab, and on recitation group work attempt to get students to integrate concepts and apply them to interesting examples. For instance, we use Newton’s Laws of motion to analyze the behavior of pulley systems. Student may have a problem that has them analyze the pulley system of a crane being used on a construction site. There could be a problem that uses empirical laws of kinetic and static friction to analyze a scene of a car accident or analyze the usefulness of antilock braking systems. As students perform the work for these problems, we ask them to state which physical principles they are using for their analysis. This reinforces the idea of putting different concepts together to form a cogent argument. [248 words]

5. **Expected Learning Outcome 2.2: Successful students are able to evaluate social and ethical implications of natural scientific discoveries.** Please link this ELO to the course goals and topics and indicate *specific* activities/ assignments through which it will be met. *(50-700 words)*

The topics of the course, other than special relativity, are primarily scientific discoveries that took place in the 17th and 18th century. Special Relativity is a product of the early 20th century. The earlier concepts coincide with the scientific revolution of the time and the period of the Enlightenment. We discuss how Newton's Laws of Motion overturned thousands of years of philosophical thought from philosophers such as Aristotle. The scientific development of this time was a precursor to the Industrial Revolution of the 19th century. (It should be noted that perhaps the most important topics for Industrial Revolution are thermodynamics and electromagnetism, which are covered in second semester physics.)

We discuss the human aspects and struggles of the scientists that made the discoveries. This includes the contributions from women such as Émilie du Châtelet who dared to challenge some of Newton's views on the motion (specifically energy) of objects. As mentioned earlier, Emmy Noether's theorem is foundational for many physical theories. She struggled against prejudices as a woman in the sciences and as a person of Jewish decent in Germany near the beginning of the twentieth century. More recently, in the 1960s, Vera Rubin, an astronomer, turned her attention to rotational behavior of galaxies because of a hostile and unwelcoming environment. She discovered important early evidence of Dark Matter, a topic still being intensely studied today. We also explore how the insights and ideas of some scientists may have not been immediately accepted or perhaps even rejected, but as time passed these ideas were shown to be correct.

Special and General Relativity are often referred to as "classical theories", but they are foundational for much of modern physics. Special Relativity is accessible for students at the introductory level and provides an introduction into a whole new view of space and time. As mentioned earlier, we discuss experiments that have validated these theories and their impact on our daily lives through GPS. Special Relativity also introduces the students to the famous equation $E = mc^2$. This relationship between mass and energy has led to a deeper understanding of the subatomic world. It has also led to the development of nuclear energy and the chilling prospects of nuclear warfare. As we introduce these topics in lecture from the scientific side, we also discuss the implications of these discoveries.

These issues do not lend themselves to quantitative calculations. However, we integrate them into the course in several ways. Topics are introduced through reading assignments and discussion during lecture. In addition, we replace one of the hand-in homework assignments, which are normally computational, with an assignment that asks the students to write a short biography about one of the scientists that has contributed to the topics being studied in the course. We also add problems to the recitation Group Work assignments that are discussion points rather than calculations.

The student will be able to discuss initially in their small groups, then in a larger discussion of the full recitation section.   [496 words]

6. **Expected Learning Outcome 2.3: Successful students are able to critically evaluate and responsibly use information from the natural sciences.** Please link this ELO to the course goals and topics and indicate *specific* activities/assignments through which it will be met. *(50-700 words)*

Problem solving and critical analysis is a central component of this course. As discussed above, we use rubrics that focus on process rather than the final result. Part of that process is critically evaluating the answer. We teach the students how to make order of magnitude calculations. When answers are determined, we ask whether the approximate size of the answer makes sense. Does the algebraic sign make sense? Is the answer physically possible? Does the answer have the correct units? We have the students consider limiting cases, where a physical parameter is taken to an extreme, then asks whether their answer has the behavior expected. All of these exercises attempt to get the student to think carefully about the answer they have derived and consider whether it is consistent with what they expect and know about the physical world. These approaches are discussed on the very first day of class and repeated throughout the semester in homework, group work, and lab. [161 words]