Term Information

Effective Term	Autumn 2024

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	1248
Course Title	Mechanics, Work, and Energy
Transcript Abbreviation	Mech Work & Energy
Course Description	PHYSICS 1248 is the first course in a two-course series, for students in physical sciences, mathematics, and engineering. This course covers Newton's Laws, work and energy. The physics content in relation to these topics is covered in the same depth and rigor as PHYSICS 1250, but proceeds at a slower pace, so that the course covers about ½ of the PHYSICS 1250 content.
Semester Credit Hours/Units	Fixed: 4

Offering Information

Length Of Course	14 Week, 12 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

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq or concur: Math 1140, 1141
Exclusions	Not open to students with credit for 1250.
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

Natural Sciences

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Students shall demonstrate conceptual understanding of Newton's Laws of motion and conservation laws.
- Students shall apply their physics understanding using their developed problem solving skills to solve practical problems involving a variety of contexts involving matter and its interactions.
- Students will also be able to create, interpret, and evaluate various representations of physical quantities including (position, velocity, acceleration, time, force, momentum, impulse, energy, work, and power).

Content Topic List

- Uniform Motion, Circular Motion, Projectile Motion, Gravitation, Newton's Laws, Work and Energy

Sought Concurrence

No

Attachments

- 1248 Syllabus.pdf: Syllabus

  (Syllabus. Owner: Gramila,Thomas J)
- GE Foundations 1248.pdf: GE Statement

  (GEC Model Curriculum Compliance Stmt. Owner: Gramila,Thomas J)
- Course_Request_Letter_PHYSICS_1248_9.pdf: Course motivation

  (Cover Letter. Owner: Gramila,Thomas J)

Comments

- Adjustments made to partner course Physics 1249. Thsi submission is unchanged. *(by Gramila,Thomas J on 01/24/2024 12:39 PM)*
- Let's discuss this proposed series in January. There are some things that are confusing. *(by Vankeerbergen,Bernadette Chantal on 12/22/2023 12:05 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Gramila,Thomas J	12/09/2023 07:16 PM	Submitted for Approval
Approved	Humanic,Thomas John	12/10/2023 08:14 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	12/22/2023 11:38 AM	College Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	12/22/2023 12:05 PM	ASCCAO Approval
Submitted	Gramila,Thomas J	01/24/2024 12:39 PM	Submitted for Approval
Approved	Humanic,Thomas John	01/24/2024 03:08 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	01/24/2024 03:46 PM	College Approval
Pending Approval	Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Neff,Jennifer Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	01/24/2024 03:46 PM	ASCCAO Approval

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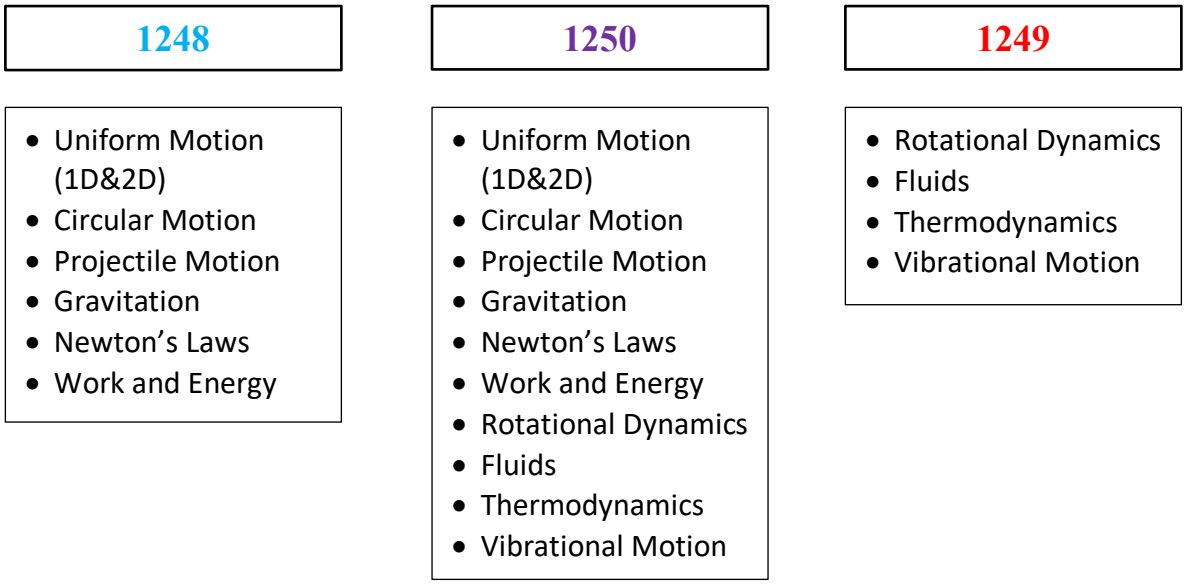
November 14, 2023

Dear Arts & Sciences Curriculum Committees,

I propose two new introductory physics courses, PHYSICS 1248 (Mechanics, Work, and Energy) and PHYSICS 1249 (Rotational Dynamics, Thermal Physics, and Vibrational Motion), as a new pathway for students who cannot immediately enroll into PHYSICS 1250 (Mechanics, Work and Energy, Thermal Physics) due to math placement and would potentially benefit from a reduced pace. The 1248 and 1249 courses combined would be equivalent in content to PHYSICS 1250 but would not require mastery or readiness for calculus. Students successful in this two-semester sequence (and 1251 math prerequisites) would subsequently be ready to take PHYSICS 1251 (E&M, Waves, Optics, Modern Physics). **Figure 1** lists the topics of the existing PHYSICS 1250 course and the proposed PHYSICS 1248 and 1249 courses.



The model for this course is based on a successful model (two-semester mechanics course) at Rutgers University (Extended Analytical Physics 1a and 1b, EAP). This course was transformed and taught by Suzanne White Brahmia who found it to be successful in supporting women and Black and Latinx students (referred to as Underrepresented Minorities) in terms of course completion and persistence. **Table 1** below (from White Brahmia, 2008) shows the passing rate for first-year physics students before and after the implementation of the EAP sequence.

Table 1. Passing rate of first-year physics, API and EAP I combined.

	All	Women	Underrepresented Minorities
Before ('85 & '85)	$64\% \pm 1\%$	$55\% \pm 2\%$	$28\% \pm 1\%$
After ('92 & '93)	$76\% \pm 2\%$	$76\% \pm 3\%$	$59\% \pm 1\%$
Current ('07 & '08)	$73\% \pm 1\%$	$71\% \pm 1\%$	$64\% \pm 1\%$

Table 2 (from White Brahmia, 2008) shows the completion of STEM degrees at Rutgers University within six years. Note the change in the percentage of students from minoritized ethnic/racial groups who completed their STEM degrees within six years after the implementation of this course.

Table 2. Completion of STEM degree at Rutgers University within six years.

	All	Women	Underrepresented Minorities
Before ('85 & '85)	$45\% \pm 3\%$	$32\% \pm 4\%$	$8\% \pm 4\%$
After ('92 & '93)	$57\% \pm 3\%$	$59\% \pm 4\%$	$53\% \pm 4\%$
Current ('07 & '08)	$68\% \pm 2\%$	$70\% \pm 3\%$	$58\% \pm 3\%$

I taught this two-semester sequence at Rutgers University Fall 2017 - Spring 2023. **Table 3** below provides the performance for students in Analytical Physics 2a (Electricity and Magnetism) who took EAP with me and students who took AP (the traditional calculus-based sequence) in 2017 and 2018.

Table 3. Performance in Physics 2a	**EAP students' grades of C or better**	**EAP students' grades of D, F, or Withdrew**	**AP students' grades of C or better**	**AP student grades of D, F, or Withdrew**
Fall 2017	79% $(n = 27)$	21% $(n = 7)$	89% $(n = 505)$	11% $(n = 64)$
Fall 2018	85% $(n = 40)$	15% $(n = 7)$	94% $(n = 580)$	6% $(n = 35)$

Despite taking the EAP course prior to taking or passing calculus, students in EAP performed on par with students who took calculus with the majority of these students passing Physics 2a. While I did not publish findings on the effectiveness of this course, a t-test revealed that one cohort of students who took the extended two-semester sequence with me performed no differently in the Electricity and Magnetism course than their calculus-ready peers who took the traditional sequence.

The purpose of the proposed two-semester course is to provide an alternative pathway to accepted OSU students interested in physics and engineering that allows them to take physics their first year, likely shortening their time to degree.

A similar letter was sent to Dr. David Tomasko, Associate Dean for Undergraduate Education and Students Services in the College of Engineering.

Sincerely and respectfully,

Geraldine L. Cochran, PhD.
Associate Professor

Department of Physics
The Ohio State University
Cochran.604@osu.edu

Course Number: 1248
Course Title: Mechanics, Work, and Energy

Instructor: Dr. Geraldine L. Cochran
Office: Physics Research Building Room 1006
Email: cochran.604@osu.edu
Office Hours: TBD

Course Description: PHYSICS 1248 is the first course in a two-course series, for students in physical sciences, mathematics, and engineering. This course covers Newton's Laws, work and energy. The physics content in relation to these topics is covered in the same depth and rigor as in PHYSICS 1250, but is about ½ of the PHYSICS 1250 content.

Note: There is a second course, PHYSICS 1249. The PHYSICS 1249 course will be the rest of the PHYSICS 1250 content. The combination of PHYSICS 1248 + PHYSICS 1249 is equivalent to PHYSICS 1250.

Pre-req / Co-req: Math Placement Level M, N or R.

Course Format (4 credits): This course follows a weekly cycle.

- **Tuesday (Lecture 1, 55 min):** Interactive lectures will introduce course topics and offer an opportunity test your understanding of lecture topics without penalty.
- **Wednesday (Lab, 125 min):** Labs meet in-person. Students work together in the same assigned discussion groups as in recitation.
- **Thursday (Lecture 2, 55 min):** Interactive lecture
- **Friday (Homework 1):** Focuses on conceptual understanding, shorter (~30 minutes)
- **Sunday (Homework 2):** Focuses on problem solving, longer (~90 minutes)
- **Monday (Recitation, 55 min):** All recitations require group work (GW). Students are required to attend for credit and must submit GW assignments on Carmen.

Note: Exams are given on Wednesday during lab times. Exam duration is 120 minutes.

Carmen Canvas carmen.osu.edu: Carmen is the Learning Management System (LMS) used at Ohio State. It is the central hub from which your course will be conducted. Course **announcements** will be made on Canvas. Course resources (e.g. practice exams) will be uploaded to Canvas. Please check Canvas **several times a week** to stay up-to-date.

Required Textbook, Homework System, and Lab Manual:

- ✔ *College Physics: Explore and Apply, 2e by Etkina, Planinsic, and Van Heuvelen.* ***You do not need to buy the entire textbook. You should purchase a modified version of the textbook that only covers mechanics. You can purchase the e-text combined with Mastering Physics access*** *from Pearson or the bookstore.* ***Mastering Physics is required for homework.***
- ✔ ***A lab manual is required.*** Please contact the Barnes & Noble bookstore on High Street. ***Students must bring the lab manual to labs that involve experiments.***

To ensure you purchase access to the correct Mastering Physics textbook version and homework system, please, use Carmen Canvas to access Pearson and use the course key: MPCochranXXXXXX.

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Your course grade is determined by the following:

Unit 1 Exam: 14% This is a 120-minute, closed book exam on **September 18**.

Unit 2 Exam: 14% This is a 120-minute, closed book exam on **October 30**.

Unit 3 Exam: 14% This is a 120-minute, closed book exam on **December 4.**

***Makeup exams are offered one week after the regularly scheduled exam. Exams that are not made up within two weeks will receive a grade of 0.**

Design Practicals (2): 14%. There are two experimental design practicals during the semester. This assignment is completed as a group. Your grade is based on the accuracy of your predictions. Your predictions are based on your conceptual knowledge of physics and your ability to problem solve. Extra credit on your Design Practical is added to your Unit Exam Grade! So, try your best!

Recitation Grade (Workshop): 14%. Your recitation grade is determined by activities you complete during the workshops. This may include participation in workshop activities, completion of worksheets, quizzes, and group practice exams.

Online Homework: 14% Online homework is due Fridays and Sundays by 11:59 pm and through Mastering Physics. LATE HOMEWORK IS PENALIZED AUTOMATICALLY THROUGH MASTERING PHYSICS. You lose 1% for each day it is late. So, you can still submit homework late and earn partial credit.

Labs: 14% Each numbered Experiment has a numbered Prelab. Prelabs are due the Sunday prior to the lab at 11:59pm. Labs should be completed in-person during lab time. Credit will not be given to labs that are not completed in-person.

Course Surveys: 2% Course presurveys are graded based on completion and not accuracy. Course surveys are administered during Lab. Pre-course surveys are held on **August 21.** Post-course surveys are held on **November 6.**

Lecture Participation – Participation in lecture as evidenced by responses to Learning Catalytics questions will be extra credit (up to 3%). The points will be tracked via Mastering Physics and Canvas throughout the semester. However, the extra credit will be finalized and added at the end of the semester. Learning Catalytics points will be administered as 0.7 for participation and 0.3 for the correct answer. So, an incorrect answer is 0.7 point. The correct answer is 1 point.

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Table of Course Weights

Unit 1 Exam	14%
Unit 2 Exam	14%
Unit 3 Exam	14%
Design Practicals	14%
Workshop (Recitation)	14%
Mastering Physics Homework	14%
Labs	14%
Course Surveys	3%
Lecture Participation	2%
Total	**103%**

Course Letter Grade Assignment: Once your overall point total (final score) has been calculated using the weighting scheme shown above, your letter grade will be assigned based on the following scale:

Total Score (%)	Letter Grade
$>$**92**	**A**
88 $\leq$ **score** $<$**92**	**A-**
84 $\leq$ **score** $<$**88**	**B+**
80 $\leq$ **score** $<$**84**	**B**
76 $\leq$ **score** $<$**80**	**B-**
72 $\leq$ **score** $<$**76**	**C+**
67 $\leq$ **score** $<$**72**	**C**
62 $\leq$ **score** $<$**67**	**C-**
56 $\leq$ **score** $<$**62**	**D+**
50 $\leq$ **score** $<$**56**	**D**
$<$**50**	**E**

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Course Title: Mechanics, Work, and Energy

General Education Foundations: Natural Sciences
Expected Learning Outcomes:

1.1. Explain basic facts, principles, theories, and methods of modern natural sciences, and describe and analyze the process of scientific inquiry.

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.

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.

This course accomplishes 1.1. Students will know facts, principles, laws, and methods of modern natural sciences that govern motion and conservation laws. After completion of the associated lab for this course students will be able to describe and analyze the process of scientific inquiry.

This course accomplishes 1.2 Students will use foundational concepts and models to understand and evaluate physical concepts. They will then identify when and why these models break down for more complex situations. New scientific knowledge will then be used to refine the models to something that better suits the more complex situations.

This course accomplishes 1.3. After completion of the associated lab and recitations for this course students will have experience employing 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 Successful students are able to analyze the inter-dependence and potential impacts of scientific and technological developments.

2.2 Successful students are able to evaluate social and ethical implications of natural scientific discoveries.

2.3 Successful students are able to critically evaluate and responsibly use information from the natural sciences.

This course accomplishes 2.1 by allowing for discussion fo the application of physical laws and conceptual understanding of the way the world works to technology used today.

This course accomplishes 2.2 by allowing students the opportunity to evaluate social and ethical implications of natural scientific discoveries as introduced in lecture and via questions on lab worksheets.

This course accomplishes 2.3 by providing multiple opportunities for students to determine if multiple representations of motion are consistent and physically possible.

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Additional Important Information:

ACADEMIC MISCONDUCT

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

DISABILITY SERVICES

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. 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. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are isolating while waiting for a COVID-19 test result, please let me know immediately. Those testing positive for COVID-19 should refer to the Safe and Healthy Buckeyes site for resources. Beyond five days of the required COVID-19 isolation period, I may rely on Student Life Disability Services to establish further reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

RELIGIOUS ACCOMMODATIONS

It is Ohio State's policy to reasonably accommodate the sincerely held religious beliefs and practices of all students. The policy permits a student to be absent for up to three days each academic semester for reasons of faith or religious or spiritual belief.

Students planning to use religious beliefs or practices accommodations for course requirements must inform the instructor in writing no later than 14 days after the course begins. The instructor is then responsible for scheduling an alternative time and date for the course requirement, which may be before or after the original time and date of the course requirement. These alternative accommodations will remain confidential. It is the student's responsibility to ensure that all course assignments are completed.

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. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

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Week	Day (Date)	Activity	Relevant Textbook Sections
1	Sun (8/18)		
	Mon (8/19)	**No Classes**	
	Tues (8/20)	**Lecture 1:** Introduction, Review of Syllabus, Models	
	Wed (8/21)	**Lab:** Presurveys	
	Thurs (8/22)	**Lecture 2:** Physical Quantities & Dimensional Analysis	1.1 - 1.3 (Modeling, Physical Quantities)
	Fri (8/23)	**Homework 1 Due at 11:59 pm**	1.1 - 1.3 (Modeling, Physical Quantities)
2	Sun (8/25)	**Homework 2a** Due at 11:59 pm	1.1 - 1.3 (Modeling, Physical Quantities)
	Mon (8/26)	**Recitation:** Symbols Representing Physical Quantities	1.1 - 1.3 (Modeling, Physical Quantities)
	Tues (8/27)	**Lecture 1:** Making Estimates	1.4 (Making Rough Estimates)
	Wed (8/28)	**Lab:** Exponents & Dimensional Analysis, Prefixes & Estimates	1.4 (Making Rough Estimates)
	Thurs (8/29)	**Lecture 2:** Uniform Motion	2.1 - 2.2, 2.4 (Descriptions of Motion)
	Fri (8/30)	**Homework 2b Due at 11:59 pm**	1.1 - 1.4 (Making Rough Estimates)
3	Sun (9/1)	**Homework 3a Due at 11:59 pm**	Chapter 1
	Mon (9/2)	**No Classes**	
	Tues (9/3)	**Lecture 1:** Graphical Representations of Uniform Motion	2.5 - 2.6 (Representing Motion, Constant Velocity Motion)
	Wed (9/4)	**Lab:** Fastness Index & Constant Velocity Motion Problems	2.5 - 2.6 (Representing Motion, Constant Velocity Motion)
	Thurs (9/5)	**Lecture 2:** Constant Acceleration Motion	2.7 - 2.9 (Motion at Constant Acceleration)
	Fri (9/6)	**Homework 3b Due at 11:59 pm**	2.5 - 2.9

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4	Sun (9/8)	**Homework 4a & Prelab Due at 11:59 pm**	2.5 - 2.9
	Mon (9/9)	**Recitation:** Speeding up Index & Constant Acceleration Motion	2.7 - 2.9 (Motion at Constant Acceleration)
	Tues (9/10)	**Lecture 1:** Accelerated Motion & Review of Vectors	2.9 & 2.3 (Constant Acceleration & Operations with Vectors)
	Wed (9/11)	**Lab:** Experiment 1 - 1D Kinematics	Chapter 2
	Thurs (9/12)	**Lecture 2:** Review of Vectors continued	2.3 (Operations with Vectors continued)
	Fri (9/13)	**Homework 4b Due at 11:59 pm**	Chapter 2
5	Sun (9/15)	**Homework 5a Due at 11:59 pm**	Chapter 2
	Mon (9/16)	**Recitation:** Practice Exam	Chapters 1 & 2
	Tues (9/17)	**Lecture 1:** Unit 1 Review	Chapters 1 & 2
	Wed (9/18)	**Lab: Exam 1**	Chapters 1 & 2
	Thurs (9/19)	**Lecture 2:** Prep for Design Practical	Chapters 1 & 2
	Fri (9/20)	**No Homework Due: Prepare for Design Practical**	Chapters 1 & 2
6	Sun (9/22)	**No Homework Due: Prepare for Design Practical**	Chapters 1 & 2
	Mon (9/23)	**Design Practical 1: Uniform Motion**	Chapters 1 & 2
	Tues (9/24)	**Lecture 1: Exam 1 Discussion**	Chapters 1 & 2
	Wed (9/25)	**No Lab Today**	
	Thurs (9/26)	**Lecture 2: Intro to Forces (in 2D)**	3.1 - 3.4 (representing interactions, adding forces, inertial references frames)
	Fri (9/27)	**Homework 6 Due at 11:59 pm**	3.1 - 3.4 (representing interactions, adding forces, inertial references frames)

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7	Sun (9/29)	**Homework 7a & Prelab Due at 11:59 pm**	3.1 - 3.4 (representing interactions, adding forces, inertial references frames)
	Mon (9/30)	**Recitation:** Tug o' War Index	3.1 - 3.4 (representing interactions, adding forces, inertial references frames)
	Tues (10/1)	**Lecture 1:** Creating Force Diagrams	3.1 (Describing, representing interactions)
	Wed (10/2)	**Lab:** Experiment II - Vectors	3.1 - 3.4 (representing interactions, adding forces, inertial references frames)
	Thurs (10/3)	**Lecture 2:** Hooke's Law & Friction	4.3 (Friction)
	Fri (10/4)	**Homework 7b Due at 11:59 pm**	Chapter 3
8	Sun (10/6)	**Homework 8a & Prelab Due at 11:59 pm**	Chapter 3
	Mon (10/7)	**Recitation:** Force Diagrams & Problem Solving w Forces	3.1 - 3.4 (representing interactions, adding forces, inertial references frames)
	Tues (10/8)	**Lecture 1:** Applying Newton's Laws Part 1	3.4 - 3.7 (Newton's 1st & 2nd Laws, Gravitational Force)
	Wed (10/9)	**Lab:** Experiment V - Static Friction	4.3 (Friction)
	Thurs (10/10)	**No Classes**	
	Fri (10/11)	**No Classes**	
9	Sun (10/13)	**No Homework Due**	
	Mon (10/14)	**PRELab Due at 11:59 pm** **Recitation:** Stickiness Index and solving problems with friction	4.3 (Friction)
	Tues (10/15)	**Lecture 1:** Applying Newton's Laws Part 2	4.1 - 4.4 (Force components and skills for analyzing forces in 2D)
	Wed (10/16)	**Lab: Experiment III - Dynamic Forces**	Chapter 4
	Thurs (10/17)	**Lecture 2:** Projectile Motion	4.5 (Projectile Motion)
	Fri (10/18)	**Homework 9 Due at 11:59 pm**	Chapter 4
10	Sun (10/20)	**Homework 10a & Prelab Due at 11:59 pm**	Chapter 4
	Mon (10/21)	**Recitation:** Projectile Motion	4.5 (Projectile Motion)
	Tues (10/22)	**Lecture 1:** Uniform Circular Motion	5.1 - 5.4 (Circular Motion)
	Wed (10/23)	**Lab:** Experiment IV - 2D Kinematics	4.5 (Projectile Motion)
	Thurs (10/24)	**Lecture 2:** Gravitation	5.5 (The Law of Universal Gravitation)
	Fri (10/25)	**Homework 10b Due at 11:59 pm**	Chapters 3 - 5

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11	Sun (10/27)	**Homework 11a Due at 11:59 pm**	Chapters 3 - 5
	Mon (10/28)	**Recitation:** Uniform Circular Motion and Gravitation	5.1 - 5.5 (Uniform Circular Motion & Gravitation)
	Tues (10/29)	**Lecture 1:** Unit 2 Exam Review	Chapters 3 - 5
	Wed (10/30)	**Lab:** Unit 2 Exam	Chapters 3 - 5
	Thurs (10/31)	**Lecture 2:** Design Practical Discussion	Chapters 3 - 5
	Fri (11/1)	**No Homework Due:** Prepare for Design Practical	Chapters 3 - 5
12	Sun (11/3)	**No Homework Due:** Prepare for DP	Chapters 3 - 5
	Mon (11/4)	**Design Practical 2:** Projectile Motion	Chapters 3 - 5
	Tues (11/5)	**Lecture 1:** Exam 2 Discussion	Chapters 3 - 5
	Wed (11/6)	**Lab: Posttests (Full credit for completion)**	Chapters 1 - 5
	Thurs (11/7)	**Lecture 2:** Impulse & Momentum Part A	6.1 - 6.3 (Mass accounting, linear momentum, impulse)
	Fri (11/8)	**Homework 12 Due at 11:59 pm**	
13	Sun (11/10)	**Homework 13a & Prelab Due at 11:59 pm**	6.1 - 6.3 (Mass accounting, linear momentum, impulse)
	Mon (11/11)	**No Classes**	
	Tues (11/12)	**Lecture 1:** Impulse & Momentum Part B	6.4 - 6.5 (The generalized impulse-momentum principle)
	Wed (11/13)	**Lab:** Experiment VII - Conservation of Momentum	6.1 - 6.3 (Mass accounting, linear momentum, impulse)
	Thurs (11/14)	**Lecture 2:** Impulse & Momentum Part C	6.6 - 6.7 (Jet propulsion and collisions in 2D)
	Fri (11/15)	**Homework 13b Due at 11:59 pm**	Chapter 6
14	Sun (11/17)	**Homework 14a & Prelab Due at 11:59 pm**	Chapter 6
	Mon (11/18)	**Recitation:** Mojo Index, Rocket Boost Index, and Weightlifting Index	Chapter 6 & Intro to Chapter 7 (Work and Energy)
	Tues (11/19)	**Lecture 1:** Work & Energy Part A	7.1 - 7.2 (Work and Energy, Conservation of Energy)
	Wed (11/20)	**Lab:** Experiment VI - Conservation of Energy	Chapter 7
	Thurs (11/21)	**Lecture 2:** Work & Energy Part B	7.3 - 7.6 (Classifying Energy & Tracking Transformation)
	Fri (11/22)	**Homework 14b Due at 11:59 pm**	Chapters 6 & 7

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15	Sun (11/24)	**Homework 15a Due at 11:59 pm**	Chapters 6 & 7
	Mon (11/25)	**Recitation:** Understanding Impulse, Momentum, & Collisions	Chapters 6 & 7
	Tues (11/26)	**Lecture 1:** Collisions	7.7 - 7.8 (Collisions & Power)
	Wed (11/27)	**No Classes**	
	Thurs (11/28)	**No Classes**	
	Fri (11/29)	**No Classes**	
16	Sun (12/1)	**No Homework Due**	
	Mon (12/2)	**Recitation:** Practice Exam	Chapters 6 & 7
	Tues (12/3)	**Lecture 1:** Unit 3 Exam Review	Chapters 6 & 7
	Wed (12/4)	**Lab: Unit 3 Exam (Last Day of Classes)**	Chapters 6 & 7
	Thurs (12/5)		
	Fri (12/6)	**First Day of Final Exams**	

GE Rationale: Foundations: Natural Science (4 credits)

Requesting a GE category for a course implies that the course fulfills all expected learning outcomes (ELOs) of that GE category. To help the reviewing panel evaluate the appropriateness of your course for the Foundations: Natural Sciences, please answer the following questions for each ELO.

A. Foundations

Please explain in 50-500 words why or how this course is introductory or foundational in the study of Natural Science.

This course is an introduction to ways of understanding, explaining, and describing physical phenomenon with a focus on motion and laws of conservation. Students will get an introduction to the laws that govern motion, various ways of representing motion (verbal descriptions, mathematical equations, data tables, and kinematics graphs). Students will be introduced to conservations laws such as conservation of mass, conservation of energy, and conservation of momentum. Students will learn to represent transfers of conserved physics quanities through verbal descriptions, mathematical equations, and bar charts. (85 words)

B. Specific Goals for Natural Sciences

GOAL 1: Successful students will engage in theoretical and empirical study within the natural sciences, gaining an appreciation of the modern principles, theories, methods, and modes of inquiry used generally across the natural sciences.

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.

This course will utilize two research-supported, inquiry-based approaches to learning science concepts: the Investigative Science Learning Environment (ISLE) and Modeling Instruction in Physics (MI-P). Materials developed for these two approaches will be utilized in recitations and labs. The lectures follow an ISLE approach. Students will thus describe and analyze the process of scientific inquiry. Students will be able to explain basic facts, principles, and laws governing physical phenomena in relation to motion, work and energy, and impulse and momentum.

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.

In the course we explain how foundational concepts and the models we utilize are refined to account for more complex situations. This follows the way that scientific understanding and knowledge is continually refined to account for new observations of physical phenomenon. As one example, students start with a model of uniform motion in a straight line. We then illustrate through activities that this model breaks down when an object is no longer moving as a straight line or when the motion is not uniform. We build on this

initial model to created models for accelerated (non uniform) motion, uniform circular motion, and projectile motion.

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.

The 1- credit hour lab included in this course allows students to learn through exploration, discovery, and collaboration. Students complete a pre-lab activity that sometimes consists of conceptual questions and other times simple calculations. During the lab students work in groups of 3 or 4 to make predictions, setup experiments, collect data, analyze data, and interpret findings. The lab component is a mixture of traditional lab (follow instructions), directed observations, and design practicals (apply your knowledge to a physical, real-world situation). As an example, during the projectile motion lab students will use their conceptual understanding and problem solving skills to determine where a projectile will land when launched from a projectile launcher at a given height and angle.

GOAL 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 Outcome 2.1: Successful students are able to analyze the inter-dependence and potential impacts of scientific and technological developments.

In this course we discuss the application of physical laws and conceptual understanding of the way the world works in connection to technology used today. As a part of these discussions, we also consider the implications of that technology on people and the planet. As an example, when we cover impulsive forces and collisions we discuss the invention of seatbelts and airbags. We also talk about the future of car safety equipment given the recent use of self-driving vehicles.

Expected Learning Outcome 2.2: Successful students are able to evaluate social and ethical implications of natural scientific discoveries.

Building on what was written for GE 2.1, students are given the opportunity to evaluate social and ethical implications of natural scientific discoveries through lecture discussions and recitation activities. In lecture, these specific opportunities for evaluation are connected to lecture problems with contexts that connect to technology and scientific discoveries. Students are required to solve the problem, but also answer qualitative questions connected to the topic. In recitation this is built into the qualitative discussion questions, which replace the traditional conceptual questions or quantitative problem solving.

Expected Learning Outcome 2.3: Successful students are able to critically evaluate and responsibly use information from the natural sciences.

After completion of the associated labs and coursework students will be able to critically evaluate scientific information pertaining to physical laws and understand the limitations of those laws. Students will also be able to responsibly use the knowledge gained in the course to explain physical phenomena. For example, students will be able to evaluate information related to motion from various forms of

representation. They will be able to determine if multiple representations of motion are consistent and/or possible.

Students will also be able to evaluate the possibility of phenomena occurring using the laws of conservation. They will be able to differentiate between a physical quantity being constant within a system and conserved within nature. They will also learn how to track physical quantities to determine if there is a violation of a conservation law using both mathematical representation and visual representation via bar charts.