PHYS 0205 - PRINCIPLES OF PHYSICS: MECHANICS

Catalog Description

Formerly known as PHYS 4A (PHYS 205 and 205L, combined)
Prerequisite: Completion of MATH 30 and 31 with grades of "C" or better (MATH 31 may be taken concurrently); AND PHYS A or PHYS 105, or high school physics with grade(s) of "C" or better
Corequisite: Concurrent enrollment in PHYS 205L
Advisory: Eligibility for ENGL 11 strongly recommended
Hours: 72 lecture
Description: Calculus-based introduction to the principles of kinematics, dynamics, energy, momentum, rotational motion, gravitation and fluids. The Physics 205/210/215 series presents the general principles and analytical methods used in physics for physical science and engineering majors. (combined with PHYS 205L, C-ID PHYS 205) (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Use calculus, trigonometry, and algebra to solve problems associated with Newtonian mechanics.
- CSLO #2: Identify which physical concepts associated with linear and rotational motion explain physical phenomena.
- CSLO #3: Develop an overlying and rigorous process to evaluate the behavior of physical systems obeying Newtonian mechanics.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

72

Outside of Class Hours

144

Total Student Learning Hours

216

Course Objectives

It should be noted that a thorough understanding of physics requires the student to evaluate data and synthesize ideas to solve conceptual and numerical problems. The list of outcomes below is intended to help the student in this endeavor. Thus students in Physics 205 are expected to:
I. Kinematics in One Dimension
1. Describe and explain the fundamental concepts of kinematics: position, displacement, instantaneous velocity and speed, average velocity and speed, acceleration.
2. Explain and characterize the kinematic differences between time-dependent and time-independent acceleration.
3. Apply the fundamental concepts of kinematics to solve numerical and conceptual problems in one dimensional motion involving time-dependent or time-independent acceleration. This includes the ability to identify, describe, characterize, and solve "freefall" problems near the surface of the earth.
4. Given either a position vs. time, velocity vs. time, or acceleration vs. time graph, plot graphs of the remaining two quantities for uniformly (constant) accelerated one dimensional motion.
II. Kinematics in Two and Three Dimensions
1. Describe and explain the properties of vectors which include resolution, multiplication by a scalar, their quantitative representation in both polar and component forms (using unit vector notation) and addition.
2. Perform vector addition with two or more vectors in two or three dimensions.
3. Use the properties of vectors to conceptually and mathematically describe the fundamental kinematic quantities in two and three-dimensional motion.
4. Explain how two and three-dimensional rectilinear motion can be most easily described by treating the x, y and z components of the motion independently of each other, thus reducing vector operations to algebraic operations.
5. Apply the fundamental concepts of kinematics to solve numerical and conceptual problems for rectilinear motion in two or three dimensions that involve time-dependent or time-independent acceleration. This includes the ability to recognize, describe, characterize, and solve "projectile motion" problems near the surface of the earth.
6. Describe and explain uniform circular motion, tangential velocity, centripetal (radial) acceleration, and tangential acceleration.
7. Distinguish between uniform and non-uniform circular motion.
8. Use unit vector notation to describe the position velocity and acceleration vectors of a object undergoing uniform circular motion.
9. Solve conceptual and numerical problems involving uniform circular motion.
10. Resolve the components of the acceleration vector for circular motion either in terms of tangential and radial components or in terms of standard Cartesian coordinates.
11. Describe and explain the kinematics of relative motion involving inertial reference frames (for v much less that the speed of light) and the Galilean transformation.
12. Describe how kinematics problems can be solved in different reference frames.
III. Dynamics
1. Describe and explain force, Newton's laws of motion, mass, inertia, weight, tension, normal force, Hooke's Law, sliding friction, coefficients of static and kinetic friction, equilibrium, statics, and dynamics.
2. Distinguish between mass and weight, and describe the relationship between mass and inertia.
3. Identify the limitations of Newton's laws of motion.
4. Identify the forces acting on a system by drawing a free-body diagram.
5. Explain the relationship between radial acceleration and centripetal force and distinguish between centripetal force and centrifugal force.
6. Apply Newton's Laws of motion along with free-body analysis to solve conceptual and numerical problems involving concurrent forces acting on basic physical systems that are static, exhibiting rectilinear motion, or circular motion.
IV. Work & Energy
1. Describe and explain work, the dot product, energy, kinetic energy, power, potential energy, conservative forces, non-conservative forces, spring potential energy, gravitational energy (near the surface of the earth), the work-kinetic energy theorem, conservation of mechanical energy, the relationship between the work-kinetic energy theorem and conservation of mechanical energy, and the general version of conservation of energy.

2. Calculate work for uniform and non-uniform forces involving simple paths.
3. Explain how work and energy involve the interplay of a system with surroundings.
4. Explain the limitations of the concept of work.
5. Explain the path independent nature of work done by conservative forces and the path dependent nature of work done by non-conservative forces.
6. Apply the work-kinetic energy theorem for conceptual and numerical problems involving basic physics systems.
7. Apply the law of conservation of mechanical energy for conceptual and numerical problems for simple physical systems involving conservative and/or non-conservative forces.
V. Momentum & Conservation of Momentum
1. Describe and explain linear momentum, impulse, impulse-momentum theorem, conservation of linear momentum, elastic collisions, inelastic collisions, center of mass, center of mass frame, extended object (rigid body), and the physics governing rocket propulsion.
2. Explain the fact Newton's second law relates the net force acting on a system and the acceleration of its center of mass.
3. Calculate the location of the center of mass of a system.
4. Use conservation of linear momentum to solve conceptual and numerical problems involving elastic and inelastic collision in one and two dimensions.
5. Use conservation of linear momentum to solve conceptual and numerical problems involving one dimensional elastic and inelastic collision conceptual and numerical in the center of mass frame problems.
6. Use the impulse-momentum theorem to solve conceptual and numerical collision problems in one and two dimensions.
VI. Rotational Kinematics and Dynamics
1. Describe and explain angular displacement, average and instantaneous angular velocity, and angular acceleration.
2. Explain and characterize the kinematic differences between time-dependent and time-independent angular acceleration.
3. Explain the fact that the rolling motion of a rigid body can be described in terms of the translation of its center of mass and rotation about its center of mass.
4. Apply the fundamental concepts of rotational kinematics to solve numerical and conceptual problems involving time-dependent or time-independent acceleration.
5. Describe and explain torque, lever arm, cross product, moment of inertia, parallel axis theorem, work and power for rotational motion, rotational kinetic energy, angular momentum, the first condition for equilibrium, the second condition for equilibrium, center of gravity, stress, strain, and Young's modulus.
6. Distinguish between the concepts of mass, inertia, and rotational inertia (moment of inertia).
7. Calculate the moment of inertia of:
A. discrete mass distributions
B. continuous mass distributions (at a mathematical level appropriate for the course) through the application of the proper mathematical technique.
8. Explain how the relationship between net torque and angular acceleration can be understood as the rotational analog of Newton's second law.
9. Apply the rotational analog of Newton's second law and free-body analysis to solve conceptual and numerical problems involving rotational and possibly translation motion of simple physical systems consisting of rigid bodies.
10. Explain how the kinetic energy of a rolling rigid body is the sum of the translational kinetic energy of its center of mass and its rotational kinetic energy.
11. Apply the work-kinetic energy theorem or the law of conservation of mechanical energy for conceptual and numerical problems for simple physical systems consisting of rigid bodies that exhibit pure rotational motion or rotational and translational motion.
12. Explain how torque and angular momentum depend on the choice of origin.
13. Describe and characterize the relationship between torque and the change in angular momentum, and recognize the rotational analog of the impulse-momentum theorem.
14. Use the relationship between torque and the change in angular momentum to describe the physics governing the precession of gyroscopes.
15. Solve conceptual and numerical problems involving the rotational analog of Newton's second law using the relationship between torque and angular momentum.
16. Apply the first and second conditions for equilibrium to solve conceptual and numerical problems for simple physical systems consisting of rigid bodies.
17. Solve simple problems involving Young's Modulus.
VII. Gravitation
1. Describe and explain Newton's universal law of gravitation, the gravitational field, gravitational field strength, gravitational field lines, escape speed, and Kepler's laws.
2. Use Newton's universal law of gravitation to conceptually and numerically analyze the forces acting on systems involving discrete mass distributions.
3. Apply the conservation of mechanical energy and conservation of angular momentum to solve conceptual and numerical problems involving satellite orbits, planetary orbits, and projectile problems.
4. Solve numerical and conceptual problems involving Kepler's laws.
5. Use energy considerations to describe the requirements in changing the orbit of a satellite.
6. Calculate the gravitational field due to:
A. discrete mass distributions
B. continuous mass distributions (at a mathematical level appropriate for the course) at a specific location in space through the application of the proper mathematical technique.
VIII. Properties of Matter & Fluids
1. Describe and explain the properties of fluids, density, pressure, the relationship between depth and pressure in an incompressible, Pascal's Principle, buoyant forces, Archimedes' Principle, and Bernoulli's Principle.
2. Calculate the pressure in a liquid.
3. Calculate the force due to a fluid.
4. Apply Pascal's principle to solve basic conceptual and numerical problems involving static fluids.
5. Apply Archimedes' principle to solve basic conceptual and numerical problems involving object that are either floating or submerged in static fluids.
IX. Miscellaneous Topics
1. Explain the difference between scalar and vector quantities.
2. Categorize the physical quantities covered in the course into scalar and vector quantities.
3. Describe the CGS, SI, and BE units of measurement.
4. Explain the dimensions or units associated with the physical quantities discussed in the course.

General Education Information

- Approved College Associate Degree GE Applicability
    - AA/AS - Physical Sciences
- CSU GE Applicability (Recommended-requires CSU approval)
    - CSUGE - B1 Physical Science

- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)
    - IGETC - 5A Physical Science

Articulation Information

Methods of Evaluation

- Classroom Discussions
    - Example: Example for Discussion Assessment or Objective Exam: A cart with mass m2 is connected to a mass m1 using a string that passes over a frictionless pulley, as shown in the figure. Initially, the cart is held motionless. The tension in the string is: a) m1g b) m2g c) (m1+m2)g d) (m1-m2)g e) Cannot tell from the information given Individual students will be graded based on the following two criteria for the discussion assessment: 1. Is the student participating in the discussion? 2. Did the student get the correct response? Based on how well the class responds to the question, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.
- Objective Examinations
    - Example: Example for Discussion Assessment or Objective Exam: A cart with mass m2 is connected to a mass m1 using a string that passes over a frictionless pulley, as shown in the figure. Initially, the cart is held motionless. The tension in the string is: a) m1g b) m2g c) (m1+m2)g d) (m1-m2)g e) Cannot tell from the information given Individual students will be graded based on the following two criteria for the discussion assessment: 1. Is the student participating in the discussion? 2. Did the student get the correct response? Based on how well the class responds to the question, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.
- Problem Solving Examinations
    - Example: 1. Problem Solving Examination Question on Dynamics of Rotational Motion: A partially empty spool of string of mass M and radius R is under a constant force F applied to the string as it comes off the bottom of the spool at a radius of R/3. Two possible results of this force are the spool can roll to the right or to the left. Assuming the spool is cylindrical and doesn't slip, at what angle will the spool not roll in either direction? You must show a detailed analysis for full credit. 2. Problem Solving quiz problem on Conservation of Energy: A 2.00 kg box is released from the top of a 53o incline plane a distance of 4.00 m from an uncompressed and ideal spring that is attached to the bottom of the incline. The coefficients of static and kinetic friction are 0.40 and 0.20 respectively and the spring constant is 120 N/m. a. What is the maximum compression of the spring? b. How far does the package rebound up the incline.

Repeatable

No

Methods of Instruction

- Lecture/Discussion
- Distance Learning

Lecture:

1. (In Class or Distance Learning)
2. A multimedia slide presentation is used to present concepts in rotational kinematics detail utilizing graphics and video segments for emphasis and clarity. Example problems are demonstrated by the instructor at appropriate times throughout the presentation. Students are always encouraged to ask questions in class or in the LMS discussion board throughout the presentation. (Objective: Section VI Rotational Kinematics items 1-4). (In Class or Distance Learning)
3. Several live or video demonstrations of rotational dynamics using actual equipment at appropriate times during the presentation provide more emphasis and clarity. Students are also given a complete set of lecture notes in advance and encouraged to ask questions throughout the presentation (Objective: Section VI Rotational Kinematics Dynamics 13).

Distance Learning

1. (In Class or Distance Learning)
2. An audience response system is used to ask questions on rotational motion in order to assess the level of student understanding during lecture. Based on how well students respond to the questions, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic. In the online format polling software will be used to administer the question for during live sessions. (Objective: Section VI Rotational Kinematics 1-4). (In Class or Distance Learning)
3. In class, group problem solving activities are administered to assess student understanding. The activities are also designed to get students to verbalize physical concepts to each member in the group, identify concepts that affect a physical system, and to illustrate how to build physical models. The instructors role is to facilitate the activity.. In the online modality this can be accomplished asynchronously using virtual groups or synchronously using a breakout groups feature of a live meeting software. Example: An object of mass m on an incline plane of negligible friction, angle θ and mass M is released from rest. The plane rests on a horizontal surface of negligible friction. Derive the expression for the acceleration of the incline plane (Objectives: Section III Dynamics 1-4, and 6)

Typical Out of Class Assignments

Reading Assignments

1. Read textbook chapter covering one-dimensional kinematics in preparation for class discussion. 2. Read "Amusement Park Physics" article located as an internet link under "News, Articles and Essays" in preparation for class discussion.

Writing, Problem Solving or Performance

1. Complete online homework assignment on kinematics. This is an assignment created by the instructor using an online homework service that accompanies the course textbook. Example: A person drives from town A to town B at and average speed of 30 miles per hour and then returns to town A at an average speed of 20 miles per hour. What are the average velocity and average speed for the entire trip (Hint-the average speed is not 25 miles per hour)? 2. Complete the free body analysis worksheet. You are standing on a cart of mass with wheels and you throw a ball to the right. a. Draw a free-body diagram to Identify the forces acting on the ball as it is released. b. Draw a free-body diagram to Identify the forces acting on the you as it is released. c. Draw a free-body diagram to Identify the forces acting on the cart as it is released. d. identify all action-reaction pairs. Don't forget to account for sliding friction.

Other (Term projects, research papers, portfolios, etc.)

Required Materials

- University Physics
  - Author: Young & Freedman
  - Publisher: Pearson
  - Publication Date: 2020
  - Text Edition: 15th
  - Classic Textbook?:
  - OER Link:
  - OER:
- Physics for Scientists and Engineers-Technology Update
  - Author: Serway & Jewett
  - Publisher: Cengage
  - Publication Date: 2019
  - Text Edition: 10th
  - Classic Textbook?:
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.