PHYS 200: Introductory Physics I (Rev. 7)

Physics 200: Introductory Physics I is an algebra-based course that provides introduction to classical mechanics. PHYS 200 combined with either PHYS 201 or PHYS 202 gives the equivalent of one year in introductory physics.

Course Syllabus

PHYS 200

Learning Outcomes

Upon successful completion of this course, you should be able to

- convert between different units and express a physical quantity in scientific notation using the appropriate number of significant digits.
- explain the relationships between time, displacement, velocity and constant acceleration, and use algebra to solve kinematic problems in one or two dimensions.
- analyze and solve dynamic problems using vector addition, Newton's three laws of motion, and resistive forces.
- analyze and solve work-, energy- and power-related problems using appropriate formulas and the conservation of energy principle.
- outline the conservation of linear momentum principle and apply it to solve problems that involve one- and two-dimensional (elastic and inelastic) collisions.
- define the concepts of torque and centre of mass and solve problems that involve static equilibrium of extended bodies.
- analyze and solve problems that involve the kinematics and dynamics of rotational motion and the conservation of angular momentum principle.
- describe Hooke's law and the elastic properties of solids and apply formulas for calculating Young's modulus, shear modulus, and bulk modulus.
- recall Newton's law of universal gravitation and apply it to solve problems involving the force of gravity and satellite motion.
- demonstrate skills related to performing simple experiments in classical mechanics, including experimental setup, data acquisition, data analysis, and communication of scientific results.

Course Outline

Physics 200 consists of the following ten units:

- **Unit 1:** Introduction: The Nature of Science and Physics
  - Physics: An Introduction
  - Physical Quantities and Units

- Accuracy, Precision, and Significant Figures
- Approximation

- **Unit 2:** Kinematics
  - Displacement
  - Vectors, Scalars, and Coordinate Systems
  - Time, Velocity, and Speed
  - Acceleration
  - Motion Equations for Constant Acceleration in One Dimension
  - Problem-Solving Basics for One-Dimensional Kinematics
  - Falling Objects
  - Graphical Analysis of One-Dimensional Motion

- **Unit 3:** Two-Dimensional Kinematics
  - Kinematics in Two Dimensions: An Introduction
  - Vector Addition and Subtraction: Graphical Methods
  - Vector Addition and Subtraction: Analytical Methods
  - Projectile Motion
  - Addition of Velocities

- **Unit 4:** Dynamics: Force and Newton's Laws of Motion
  - Development of Force Concept
  - Newton’s First Law of Motion: Inertia
  - Newton’s Second Law of Motion: Concept of a System
  - Newton’s Third Law of Motion: Symmetry in Forces
  - Normal, Tension, and Other Examples of Forces
  - Problem-Solving Strategies
  - Further Applications of Newton’s Laws of Motion

- **Unit 5:** Further Applications of Newton's Laws: Friction, Drag, and Elasticity
  - Friction
  - Drag Forces
  - Elasticity: Stress and Strain

- **Unit 6:** Uniform Circular Motion and Gravitation
  - Rotation Angle and Angular Velocity
  - Centripetal Acceleration
  - Centripetal Force
  - Newton’s Universal Law of Gravitation
  - Satellites and Kepler’s Laws: An Argument for Simplicity

- **Unit 7:** Work, Energy, and Energy Resources
  - Work: The Scientific Definition
  - Kinetic Energy and the Work-Energy Theorem

- Gravitational Potential Energy
- Conservative Forces and Potential Energy
- Nonconservative Forces
- Conservation of Energy
- Power
- Work, Energy, and Power in Humans
- World Energy Use

- **Unit 8:** Linear Momentum and Collisions
  - Linear Momentum and Force
  - Impulse
  - Conservation of Momentum
  - Elastic Collisions in One Dimension
  - Inelastic Collisions in One Dimension
  - Collisions of Point Masses in Two Dimensions
  - Introduction to Rocket Propulsion

- **Unit 9:** Statics and Torque
  - The First Condition for Equilibrium
  - The Second Condition for Equilibrium
  - Stability
  - Applications of Statics, Including Problem-Solving Strategies
  - Simple Machines
  - Forces and Torques in Muscles and Joints

- **Unit 10:** Rotational Motion and Angular Momentum
  - Angular Acceleration
  - Kinematics of Rotational Motion
  - Dynamics of Rotational Motion: Rotational Inertia
  - Rotational Kinetic Energy: Work and Energy Revisited
  - Angular Momentum and Its Conservation
  - Collisions of Extended Bodies in Two Dimensions

Course Materials

The PHYS 200 course is designed based on the OpenStax College Physics eTextbook, which is an open source material licensed under Creative Commons Attribution 3.0 Unported License.

In this revision of PHYS 200, the Study Guide merges relevant sections of the eTextbook with the AU-produced lab experiments, assignment questions, and detailed solutions of selected end-of-chapter problems from the eTextbook.

The Study Guide has been prepared in html code and uses the opensource MathJax JavaScript platform. This combines the accessibility of html with the beauty and convenience of the LaTeX mathematical

equations and symbols. Special effort has also been made to make the learning materials accessible on mobile devices.

An important feature is the inclusion of interactive activities using the free simulations of the PhET project. This is in addition to a number of interactive diagrams developed using the dynamic capabilities of Mathematica, which can be displayed using Wolfram Player. The Study Guide is supplemented with 3D animation videos created using text-to-speech technology software (State) developed by Xtranormal Technology Inc.

Laboratory Component

The lab is a mandatory component of the PHYS 200 course and it is worth 20% of your final grade. The six experiments listed below are based on the home lab concept, which involves performing hands-on experiments in a place of your choice.

- **Lab 1:** Graphical Analysis
- **Lab 2:** Kinematics in One Dimension
- **Lab 3:** Projectile Motion
- **Lab 4:** Hooke's Law
- **Lab 5:** Collision in Two Dimensions
- **Lab 6:** Rolling Motion

Equipment and Materials

The lab component is designed to provide quality hands-on physics experiments that are based on video analysis of moving objects. A digital video camera (e.g., a smartphone) and a personal computer are required for data collection and analysis, and for preparing the lab reports. In addition, you are expected to provide some necessary materials, considered safe common household items.

The following is a list of the household items required:

- digital camera (e.g., a smartphone)
- ruler (or measuring tape)
- rubber band (or spring)

- small container (e.g., a small plastic bag)
- 10 identical coins
- adhesive tape
- two identical spherical objects (e.g., glass marbles, billiard balls, tennis balls)
- a hoop (e.g., empty food can, short pipe)
- a solid cylinder (e.g., unopened food can, cylindrical candle, hockey puck)
- a spherical shell (e.g., tennis ball, ping-pong ball)
- a solid sphere (e.g., glass marble, billiard ball)
- an inclined surface (e.g., wooden board, large hard-cover book, binder, coffee table)

Lab Software

Experiments in this lab require the Tracker software, or alternatively Logger *Pro* 3 by Vernier. Both software can be used to perform video analysis of moving objects and generate graphical representations of experimental data.

Lab Report

The lab report is an effective way to communicate important experimental results and conclusions. There is little point in doing a wonderful experiment with great results if you cannot effectively communicate your method and findings to others. Although you have some freedom in preparing your lab report, make sure to include the following sections:

- **Cover Page** – Create a cover page for your lab report that includes the title of the experiment, your name, student ID, and date.
- **Introduction** – Provide a concise theoretical background.
- **Procedure** – Describe your procedure in your own words.
- **Pictures** – Include clear pictures (and/or videos) of your setup.
- **Data** – Organize and present the data you collect in the experiment. Also provide a description of the behaviour and apparent trend of the collected data.
- **Analysis and Discussion** – Give clear and detailed analysis of your data. Make sure to include sample calculations, especially for calculated columns in data tables. You may also need to produce graphs and perform appropriate fits. Do not forget to provide reasonable error analysis of your results and a discussion of measurement uncertainties.
- **Conclusion** – Present a summary of your findings and results.
- **Questions** – Provide detailed answers to the questions at the end of the lab report.

Lab Safety

Appropriate care should be taken due to moving objects and other potentially hazardous situations and materials. The level of risk involved in doing these labs is comparable to that of day-to-day activities and care has been taken to avoid suggesting activities that produce hazards.

It is your decision to proceed with any experiment and in making that decision, you control your own situation and assume any risks involved. It is your responsibility to act in a responsible manner to avoid hazard to yourself or members of the public.

You are expected to complete the Workplace Hazardous Materials Information System (WHMIS) training and acknowledge completion of WHMIS by checking the box on the course home page and uploading your certificate of completion prior to starting the labs.

Evaluation

Your final grade in PHYS 200 is based on the marks you achieve in two tutor-marked assignments, six lab reports, and two invigilated exams. You must achieve at least fifty per cent (50%) on the final examination and on the lab component, and an overall course grade of at least fifty per cent (50%) to pass the course. Students who do not achieve a minimum passing grade on the final exam may write a supplemental examination. There is a fee for this service.

The following chart summarizes the evaluation activities and their credit.

Activity	Credit Weight
Assignment 1	10%
Assignment 2	10%
Lab 1	3.0%
Lab 2	3.4%
Lab 3	3.4%
Lab 4	3.4%
Lab 5	3.4%
Lab 6	3.4%
Midterm Exam	20%
Final Exam	40%
Total	**20%**

Assignments

You are expected to submit two assignments, which are worth 20% of your final grade.

- Assignment 1 (covers Units 1–5)
- Assignment 2 (covers Units 6–10)

Although you may find it convenient to answer the assigned problems in the briefest possible way, you should get into the habit of showing all your work. This strategy enables the marker to identify where you are having trouble with concepts or mathematical skills. Once you have answered all the questions in a particular assignment, submit it for marking by uploading it to the appropriate drop box. Scanned copies of your handwritten solutions are acceptable.

Examinations

You are required to write two online-invigilated exams (midterm and final). Please request your exams well in advance of the dates you intend to complete them. Make sure you have your student ID number and picture identification with you at your exam.

The midterm exam covers Units 1–5 and it is worth 20% of the total course mark. The final exam covers all units (1–10), with emphasis on the second half of the course, and it is worth 40% of the total course mark. These are closed-book exams to be completed online without any printed material or electronic devices, other than a calculator. Key formulas will be provided in the online exam. Any scrap paper you use during the exam must be destroyed at the end of the exam.

Course Coordinator

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