Las Positas College
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Course Outline for PHYS 2A

INTRODUCTION TO PHYSICS I

Effective: Fall 2004

I. CATALOG DESCRIPTION:
PHYS 2A — INTRODUCTION TO PHYSICS I — 4.00 units

Introduction to the major principles of classical mechanics and electricity using pre-calculus mathematics. Includes Newtonian mechanics, energy, gravitation, fluids, thermodynamics, vibration waves and electrostatics.

3.00 Units Lecture 1.00 Units Lab

Prerequisite
MATH 20 - Pre-Calculus Mathematics
with a minimum grade of C
or

-
with a minimum grade of C
or

MATH 38 - Trigonometry with Geometry
with a minimum grade of c

Grading Methods:
Letter Grade

Discipline:

	MIN
Lecture Hours:	54.00
Lab Hours:	54.00
Total Hours:	108.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:
Before entering the course a student should be able to:

A. MATH20
B. MATH38

IV. MEASURABLE OBJECTIVES:
Upon completion of this course, the student should be able to:

A. analyze and solve a variety of problems in topics such as:
   1. linear and rotational kinematics
   2. dynamics
   3. momentum
   4. work and kinetic energy
   5. potential energy and energy conservation
   6. collisions in one- and two-dimensions
   7. rotational kinematics and dynamics
   8. static equilibrium
   9. universal gravitation
   10. fluid dynamics.
   11. Oscillatory motion
   12. Wave mechanics
   13. Thermodynamics
   14. Electric forces and fields for varying charge distributions
   15. Gauss's Law
B. operate standard laboratory equipment, including computer based data acquisition systems, such as:
   1. Universal Laboratory Interface (ULI) and/or LabPro data collection interface
   2. Logger Pro (computer-based data acquisition program by Vernier)

3. Motion Detector
4. Photogate
5. Air Track
6. Projectile Apparatus
7. Interactive Physics (computer-based simulation program)
8. Vernier Calipers
9. Micrometer
10. Multimeters
11. Power Supplies
12. Oscilloscopes
13. Function Generators
14. Basic Circuit Components (a.) Circuit Boards (Bread Boards) (b.) Resistor (c.) Capacitor

C. analyze and present laboratory data using, as necessary, computer- and calculator-based analytic, spreadsheet and graphing applications such as:
1. Graphical Analysis (computer-based data analysis program by Vernier)
2. MS Excel
3. MS Word

D. write comprehensive laboratory reports, including the following sections:
1. Introduction
2. Data
3. Data Analysis:
4. Sample Calculations
5. Graphs and Charts
6. Conclusion/Summary.

V. CONTENT:

A. Physics and Measurement
1. Standards of Length, Mass and Time
2. The Building Blocks of Matter
3. Dimensional Analysis
4. Uncertainty in Measurements and Significant Figures
5. Conversion of Units
6. Order-of-Magnitude Calculations
7. Coordinate Systems
8. Trigonometry

B. Motion in One Dimension
1. Displacement
2. Average Velocity
3. Instantaneous Velocity
4. Acceleration
5. Motion Diagrams
6. One-Dimensional Motion with Constant Acceleration
7. Freely Falling Objects

C. Vectors and Two Dimensional Motion
1. Vectors and Scalars Revisited
2. Some Properties of Vectors
3. Components of a Vector
4. Displacement, Velocity and Acceleration in Two Dimensions
5. Projectile Motion
6. Relative Velocity

D. The Laws of Motion
1. The Concept of Force
2. Newton's First Law
3. Newton's Second Law
4. Newton's Third Law
5. Some Applications of Newton's Laws
6. Force of Friction

E. Work and Energy
1. Work
2. Kinetic Energy and the Work-Kinetic Energy Theorem
3. Potential Energy
4. Conservative and Non-Conservative Forces
5. Conservation of Mechanical Energy
6. Non-Conservative Forces, Nonisolated Systems and Conservation of Energy
7. Power
8. Work Done by A Varying Force

F. Momentum and Collisions
1. Impulse and Momentum
2. Conservation of Momentum
3. Collisions
4. Glancing Collisions
5. Rocket Propulsion

G. Rotational Motion and the Law of Gravity
1. Angular Speed and Angular Acceleration
2. Rotational Motion with Constant Angular Acceleration
3. Relationships between Angular and Linear Quantities
4. Centripetal Acceleration
5. The Vector Nature of Angular Quantities
6. Forces Causing Centripetal Acceleration
7. Newton's Universal Law of Gravity
8. Gravitational Potential Energy Revisted
9. Kepler's Laws

H. Rotational Equilibrium and Rotational Dynamics
1. Torque
2. Torque and the Two Conditions for Equilibrium
3. The Center of Gravity
4. Examples of Objects in Equilibrium
5. Relationships Between Torque and Angular Acceleration
6. Rotational Kinetic Energy

7. Angular Momentum

I. Solids and Fluids
1. States of Matter
2. The Deformations of Solids
3. Density and Pressure
4. Variation of Pressure with Depth
5. Pressure Measurements
6. Bouyant Forces and Archimedes' Principle
7. Fluids in Motion
8. Other Applications of Fluid Dynamics
9. Surface Tension, Capillary Action, and Viscous Fluid Flow
10. Transportation Phenomena

J. Thermal Physics
1. Temperature and the Zeroth Law of Thermodynamics
2. Thermometers andTemperature Scale
3. Thermal Expansion of Solids and Liquids
4. Macroscopic Description of and Ideal Gas
5. Avagadro's Number and the Ideal Gas Law
6. The Kinetic Theory of Gases

K. Energy in Thermal Processes
1. Heat and Internal Energy
2. Specific Heat
3. Calorimetry
4. Latent Heat and Phase Changes
5. Energy Transfer by Thermal Conduction
6. Energy Transfer by Convection
7. Energy Transfer by Radiation
8. Resisting Energy Transfer
9. Global Warming and Greenhouse Gases

L. The Laws of Thermodynamics
1. Work in Thermodynamic Processes
2. The First Law of Thermodynamics
3. The First Law and Human Metabolism
4. Heat Engines and the Second Law of Thermodynamics
5. Reversible and Irreversible Processes
6. The Carnot Engine
7. Entropy
8. Entropy and Disorder

M. Vibrations and Waves
1. Hooke's Law
2. Elastic Potential Energy
3. Velocity as a Function of Time
4. Comparing Simple Harmonic Motion with Uniform Circular Motion
5. Position, Velocity and Acceleration as a Function of Time
6. Motions of a Pendulum
7. Damped Oscillations
8. Wave Motion
9. Types of Waves
10. Frequency, Amplitude and Wavelength
11. The Speed of Waves on Strings
12. Interference of Waves
13. Reflection of Waves

N. Sound
1. Producing a Sound Wave
2. Characteristics of Sound Waves
3. Speed of Sound Waves
4. Energy and Intensity of Sound Waves
5. Spherical and Plane Waves
6. The Doppler Effect
7. Interference of Sound Waves
8. Standing Waves
9. Forced Vibrations and Resonance
10. Standing Waves in Air Columns
11. Beats
12. Quality of Sound
13. The Ear

O. Electric Forces and Electric Fields
1. Properties of Electric Fields
2. Insulators and Conductors
3. Coulomb's Law
4. The Electric Field
5. Electric Field Lines
6. Conductors in Electrostatic Equilibrium
7. The Milikan Oil-Drop Experiment
8. The VandeGraff Generator
9. Electric Flux and Gauss's Law

P. Electric Energy and Capacitance
1. Potential Difference and Electric Potential
2. Electric Potential and Potential Energy due to Point Chrages
3. Potentials and Charged Conductors
4. Equipotential Surfaces
5. Applications
6. Capacitance
7. The Parallel Plate Capacitor
8. Combinations of Capacitors
9. Energy Stored in a Charged Capacitor
10. Capacitors with Dialectrics

VI. METHODS OF INSTRUCTION:

A. **Lecture** -
B. Problem solving.
C. Laboratory experimentation.
D. Internet and other computer-based simulations and instructional multi-media
E. **Discussion** -
F. **Demonstration** -

VII. TYPICAL ASSIGNMENTS:

A. Weekly homework assignments from textbook 1. Assigned Problems (not to be turned in): a. Chapter 4 – Questions 1, 9, 12, 13, 14, 17, 19, 21, 22, 23 b. Chapter 4 – Problems 7, 19, 23, 33, 37 2. Homework Assignment (to be turned in): a. Chapter 3 -- Problem 63 b. Chapter 4 – Problems 3, 9, 13, 17, 25, 27, 31, 43, 47; B. Laboratory reports (individual and group), including computer-based data acquisition and analysis 1. Acceleration in One Dimension: In this lab you will use an ultrasonic motion detector with a computer interface to measure the position of a moving cart as a function of time. In Part A of this experiment, you will measure the velocity of the cart on a level track, with no acceleration. In Part B, you will angle the track so that gravity accelerates the cart. 2. Conservation of Momentum II: In this lab you will verify the principles of conservation of momentum and kinetic energy in elastic and inelastic collisions, and explore collisions in the center of mass frame. C. Special exercise worksheets, problem review, and computer simulations and tutorials; both individual and group activities 1. Web assignment: Cannon Applet. Complete sections (a) through (f) and turn in with laboratory report for lab Projectile Motion. 2. Complete Exponential Growth and Population assignment listed in online syllabus. Work together in groups of two or three and turn in with report on lab Newton's Laws and Atwood's Machine. Be sure to include an Excel spreadsheet and graph with your report.

VIII. EVALUATION:

A. **Methods**

1. Exams/Tests
2. Quizzes
3. Home Work

B. **Frequency**

1. Frequency
   a. Recommend bi-weekly or tri-weekly quizzes and final exam (or) two or three midterm (unit) exams and final exam.
   b. Weekly or bi-weekly homework assignments (as described above).
   c. Weekly or bi-weekly laboratory reports (as described above).
   d. Two or more collaborative laboratory assignments per semester (as described above).
   e. Two or more computer assignments per semester (as described above).
2. Typical Problems
   a. Homework Problems
      1. (intermediate) A 72.0-kg man stands on a spring scale in an elevator. Starting from rest, the elevator ascends, attaining its maximum speed of 1.20 m/s in 0.800 s. It travels with this constant speed for the next 5.00 s. The elevator then undergoes a uniform acceleration in the negative y direction for 1.50 s and comes to a rest. What does the spring scale register (a) before the elevator starts to move? (b) during the first 0.800 s? (c) while the elevator is traveling at constant speed? (d) during the time it is slowing down?
      2. (challenging) Two particles with masses m and 3m are moving toward each other along the x axis with the same initial speeds vi. Particle m is traveling to the left, while particle 3m is traveling to the right. They undergo an elastic glancing collision such that particle m is moving downward after the collision at right angles from its initial direction. (a) Find the final speeds of the two particles. (b) What is the angle ? at which the particle 3m is scattered?
   b. Quiz Problems
      1. A projectile is fired at a ??? angle so that it just strikes the top of a mountain 2000 meters away horizontally and 1000 meters high. (a) What was the initial velocity of the projectile? (b) What total horizontal distance would the projectile travel if the mountain was not in the way?
      2. A block of ice of unknown mass is dropped into 200g of water at 23 degrees Celsius. If the resulting mixture reaches a temperature of 18.5 degrees Celsius when the ice has finished melting, what was the mass of the ice?
      3. If 100 Joules of energy flows into 2.5 moles of an unknown gas and the temperature of the gas rises by 2.4 degrees Celsius, determine the number of degrees of freedom of the gas assuming the volume is kept constant.
      4. A thin rectangular piece of wood floats in water. You slowly pour oil with a density equal to that of the wood onto the surface of the water until the height of the oil above the water is equal to twice the height of the piece of wood. Which statement is correct? (a) The wood floats on top of the oil, and some of the wood sticks into the air. (b) The wood does not change its position. (c) The wood sinks below the surface of the water. (d) The wood is half in the water and half in the oil. (e) The wood floats in the oil just above the water.
   c. Exam Problems
      1. A dart of mass mo is fired into a block of mass M. The block rests on a level, frictionless surface and is connected to a spring with spring constant k. The spring is initially un-compressed.
         a. (a) If the spring is compressed a distance d after the dart sticks to the block, what was the initial speed of the dart?
         b. (b) Was the kinetic energy conserved in the collision? If not, then what fraction of the initial energy of the dart was lost?
      2. Five particles, each of which has a mass of 0.24 kg, are fixed at positions that are equally spaced along a meter stick with one of these particles at each end. What is the moment of inertia about an axis that is perpendicular to the meter stick (which has negligible mass) and through the center of mass of this rigid body?
      3. A 5 – gram lead bullet traveling in 20?C air at 300 m/s strikes a flat steel plate and stops. What is the final temperature of the lead bullet?

IX. TYPICAL TEXTS:

1. R. Serway and J. Faughn *College Physics.* 6th ed., Brooks/Cole-Thompson, 2004.
2. J. Walker *PHYSICS.*, Prentice Hall, 2002.
3. T. Urone. *College Physics.* 2nd ed., Brooks/Cole-Thompson, 2004.
4. Las Positas College Physics 2A Laboratory Manual, available online in PDF format.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

A. Programmable scientific calculator capable of graphing
B. Campus print card