



CIEE Global Institute - Yucatan

Course name:	General Physics I (Lab Course)
Course number:	(GI) PHYS 1401 MEME
Programs offering course:	Yucatan Open Campus Block: STEM and Society
Open Campus track:	STEM and Society
Language of instruction:	English
U.S. semester credits:	4
Contact hours:	45 lecture and 45 laboratory
Term:	Spring 2020

Course Description

Students will study basic concepts of physics while gaining a deeper understanding of how the world around them is influenced and governed by Physics. They will explore Physics principles in class and laboratory, as well as the culture side of Physics: its history and the cultural significance of its principles, laws, recent developments, and continuing impacts on society. Topics covered include: motion, Newton's laws, work, energy, thermal physics and thermodynamics. Applications will include how physics informs our understanding of ourselves, our physical world and its impact on society and culture.

Learning Objectives

By the end of this course, students will be able to:

- Make proper measurements, understand units and their conversions, and how to quantify uncertainty in measurements.
- Use the scientific method as a basis of inquiry, including observation, hypothesis testing, data collection, analysis and drawing reasonable conclusions.
- Develop problem-solving skills by approaching physical phenomena mathematically as well as intuitively.
- Explain and Predict Motion: Kinematics in one and two dimensions, Dynamics, Force, Laws of Motion, Circular Motion, Gravitation, Kepler's Laws, Fundamental Forces, Rotational Motion, Torque and Angular Momentum.
- Describe and Measure Energy, including Work, Kinetic, Potential and Preservation of Energy, Power.
- Characterize Momentum: Linear momentum, momentum and force, conservation of momentum, collision and impulse, center of mass.
- Understand Heat and Its Impacts on Energy and Matter: Temperature and Kinetics, Expansion, Gas Laws, Specific Heat, Latent Heat and Heat Transfer.



- Know and follow proper laboratory safety practices.
- Collect and report data effectively: Use correct laboratory notebook skills, spreadsheets, graphing software and regression analysis.
- Assess how Physics impacts their lives and the lives of local people.

Course Prerequisites

High School Physics and High School Algebra, Geometry and Trigonometry or equivalents

Methods of Instruction

The course will be taught using lectures, class discussions, lecture activities, reading assignments, problem sets, presentations, laboratory activities and experiments. In addition, students will visit national universities and industrial facilities, conducting interviews with local physicists and Mexican students. Students will work individually and in groups in laboratory and on assigned problem sets. Students are expected to read portions of the textbook before lectures and review laboratory manual instructions before labs. Students will work in groups to present current applications of physics in their lives and in the lives of those in the local community. Students should take full advantage of generous online resources associated with the texts.

Assessment and Final Grade

Weekly Exams (5)	10 %
Problem Sets	10 %
Laboratory	30 %
Group Presentation	10 %
Final Exam (Comprehensive)	20 %
Participation	20 %
Total	100%

Course Requirements

Weekly Exams

Each week, students will take an exam based upon the previous week's material. These exams will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. Each exam will take approximately 30 minutes and comprise 5% of the final course evaluation.



Problem Sets

Problems located at the end of each chapter of the textbook will be assigned to individuals or groups by the instructor. Student solutions to these problems will be collected and discussed in review sessions. The instructor will work through or give solutions to all problems. Similar problems will appear on weekly quizzes and the final exam. Assessment for problem sets will include timely and correct completion of problems.

Laboratory

Each lab will begin with a short quiz assessing the students' preparedness. This will cover material in the laboratory manual related to the lab assigned for that day. Each lab will end with a report sheet which must be turned in at the end of the lab period. All lab report sheets must be completed in ink. Report protocol will be covered in the first lab period. Points will be deducted for failing to follow these procedures or if the lab sheet is not neatly presented. A laboratory notebook will be kept, in addition to the manual, and will contain all changes to protocols, data collected and interpretation of data. Some labs will require written lab reports. The style and content of written lab reports will be given in the first lab period.

Group Presentations

Students will investigate how Physics impacts their daily lives and the lives of local people. This will be done in groups using information from various sources, including interviewing each other and local people. A 15-minute presentation with a demonstration using physics will be graded on the overall presentation as well as each student's part in it.

Final Exam

The final exam is comprehensive. As with quizzes, this exam will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. It will include material from both lecture and laboratory.

Participation

Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to-peer feedback (after presentations), interaction with guest speakers, and attentiveness on co-curricular and outside-of-classroom activities.

Class Attendance

Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked



present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

<i>Percentage of Total Course Hours Missed</i>	<i>Equivalent Number of Open Campus Semester classes</i>	<i>Minimum Penalty</i>
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; written warning
More than 20%	3 content classes, or 5 language classes	Automatic course failure , and possible expulsion

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

Week 1 Foundational Concepts, Matter and Measurement

Session 1.1 Review of General Physics Foundational Concepts.

Students will review basic definitions, terms, common abbreviations, the scientific method, numbers and significant figures.

Reading: Chapter 1 The Nature of Science and Physics, plus assigned problems (at end of chapter)

Lab 1.1 Lab Check in, Basic Lab Safety, and Simple Measurement.



Includes mass, volume and density (Experiments 1, 2 and 3 in lab manual). Students will check into the laboratory, become familiar with the laboratory and the laboratory manual and put into practice rules of lab safety. Students will also learn to organize and record data. Using International SI units, students will organize and record data on mass, density and volume. Lab Notebook protocol will be explained with a post lab check. There will be a sample Pre-Lab Quiz (not graded). The instructor will take students on a walking tour of the city's historic district to demonstrate how Physics plays an important role in local people's lives.

Watch: Helen Czerrsi, The fascinating physics of everyday life, TED TALKS https://www.ted.com/talks/helen_czerski_fun_home_experiments_that_teach_you_physics

Homework: Bring an example of Physics in your everyday life to share for the next class period using online research.

Reading: Cronjé, F., 2013. Science, Technology and Society. *South African Review of Sociology*, 44(1), pp.180-198.

Week 2 Kinematics and Newton's Laws of Motion

Session 2.1 One Dimensional Kinematics.

Students will cover concepts of displacement (position, displacement, distance and distance traveled), vectors (scalar and vector quantities), time, velocity and speed, acceleration, falling objects and graphical analyses for one dimensional motion. They will use and master motion equations for constant acceleration in one dimension, and apply problem-solving steps and strategies. They will also describe the effects of gravity on objects in motion and the motion of objects in free fall.

Readings and Problem Sets: Chapter 2 Kinematics and select end of chapter problems

Lab 2.1 Simple Pendulum Parameters (Experiment 4 in lab manual).

In groups, students will familiarize themselves with pendulum angle, Mass, Length and Damping. Further, students will then study the addition and resolution of vectors and Newton's 1st Law of Motion, using a vector force table (Experiment 6 in lab manual). There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Session 2.2 Two-Dimensional Kinematics.

Students will explore kinematics in two dimensions, including graphic and analytic approaches to vector addition and subtraction, projectile motion and addition of velocities. Students will observe that motion in two dimensions has horizontal and vertical components. They will learn rules to add and subtract

vectors using analytical methods. Students will identify and explain properties of a projectile, such as acceleration due to gravity, range, maximum height and trajectory.

Readings and Problem Sets: Chapter 3 Two-Dimensional Kinematics and assigned problems

Lab 2.2 Uniformly Accelerated Motion (Experiment 5 in lab manual). Students will use a linear air track and wooden blocks to measure how the velocity and displacement of objects with a uniform or constant acceleration change with time. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Week 3 Newton's Laws, Circular Motion and Gravity

Session 3.1 Dynamics: Force and Newton's Laws of Motion.
Students will understand and be able to define force, mass and inertia. They will then apply these concepts to Newton's Laws of Motion: 1st Inertia, 2nd Concept of a System and 3rd Symmetry in Forces. They will study normal, tension and other forces. They will explore applications of Newton's Laws of Motion and apply problem-solving strategies to them. They will explore how four basic distinct forces account for all known phenomena: gravitational, electromagnetic, weak nuclear force and strong nuclear force.

Readings and Problem Sets: Chapter 4 Dynamics: Force and Newton's Laws of Motion and assigned problems

Lab 3.1 Newton's 2nd Law of Motion: The Atwood Machine (Experiment 7).
Students will vary the net (weight) force on an object and the total mass of the system to show the resulting accelerations can be experimentally determined from distance and time measurements. Students can then compare these time measurements with predictions from Newton's 2nd Law of Motion. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Session 3.2 Further Applications of Newton's Laws: Friction, Drag and Elasticity.
Students will discuss the general characteristics of friction, describe types of friction and calculate the magnitude of static and kinetic friction. They will also define Drag Force, learn to express it mathematically and discuss applications. Students will then state and explain Hooke's Law, use graphical representations for deformation and applied force, explain three types of deformations (changes in length, sideways shear and changes in volume), describe with examples the young's modulus, shear modulus and bulk modulus, and determine the change in length given mass, length and radius.



Readings: Chapter 5 Further Applications of Newton's Laws and assigned problems; Wilczek, F., 2004. Whence the force of $F=ma$? I: culture shock. *Physics Today*, 57(10), pp.11-12.

Lab 3.2 **Projectile Motion: The Ballistic Pendulum (Experiment 9).**
Students will explore and measure projectile motion using a ballistic pendulum. They will see how the projectile motion of an object in two dimensions is only under the influence of gravity. They will use kinematic equations to describe and predict components of such motion, including unknown initial velocity and the dependence of projectile range on angle of projection. Students will explain the use of conservation laws (linear momentum and mechanical energy) to determine initial velocity, describe the components of motion and how they determine velocity of a projectile, and tell how the range of a projectile varies with angle of projection. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Session 3.3 **Uniform Circular Motion and Gravitation**
Students will explore rotation angle and angular velocity by defining arc length, rotation angle, radius of curvature and angular velocity. They will also describe centripetal acceleration and centripetal force, applying these principles to calculate ideal speed and angle of a car turn. Students will then discuss inertial vs. non-inertial frames of reference and how they apply to the Coriolis force. They will explain Earth's gravity, the gravitational effects of the Moon and weightlessness in space in the context of Newton's Universal Law of Gravitation. They will apply these concepts to planetary motion and derive Kepler's Third Law of Circular Orbits.

Readings and Problem Sets: Chapter 6 Uniform Circular Motion and Gravitation, and assigned problems

Week 4 Work, Energy and Momentum

Session 4.1 **Work, Energy and Energy Resources.**
Students will understand work in a scientific context: the interaction of displacement and force, and whether work is positive, negative or neutral. They will explain work as a transfer of energy and net work as the result of net force, by applying the work-energy theorem. They will extend their concept of work to gravitational potential energy. This will form their understanding of conservative force, potential energy and mechanical energy. Students will move onto nonconservative forces and explore how they affect mechanical energy. Power will be defined as changes in energy over time. Students will apply physical concepts of power to the human body and world energy use.

Readings and Problem Sets: Chapter 7 Work, Energy and Energy Resources and assigned problems.



Lab 4.1 Centripetal Force (Experiment 10) and Friction (Experiment 11)
Students will study centripetal force in the laboratory using objects in uniform circular motion. After performing the experiment and analyzing data, students will explain why a centripetal force is necessary for circular motion, describe how the magnitude of centripetal force for uniform circular motion may be determined from motional parameters and summarize what determines the magnitude of centripetal force necessary to maintain constant uniform motion. For friction, students will use solid objects to understand basic concepts of friction. Students will experimentally determine coefficients of friction and tell why the normal reaction force of a surface on an object is used to determine frictional force. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Session 4.2 Linear Momentum and Collisions.
Students will define linear momentum, explain the relationship between momentum and force, state Newton's 2nd Law of Motion in terms of momentum and calculate momentum given mass and velocity. They will use these concepts to define impulse, describe conservation of momentum, elastic and inelastic collisions in one and two dimensions and to state Newton's 3rd Law of Motion. They will apply these concepts to everyday life, including collisions in sports.

Readings and Problem Sets: Chapter 8 Linear Momentum and Collisions, and assigned problems

Lab 4.2 Conservation of Linear Momentum (Experiment 8 in lab manual). Students will use an air track and collision cars to measure how the total linear momentum of a system will be the same after collision as before. A prelab quiz and post-lab notebook check will be graded.

Session 4.3 Rotational Motion and Angular Momentum.
Students will describe uniform and non-uniform circular motion, calculating angular acceleration and noting the link between linear and angular acceleration. They will observe the kinematics of rotational motion and derive rotational kinematic equations. They will explore the relationship between force, mass and acceleration, force and torque, mass and moment of inertia, and angular and linear acceleration.

Readings and Problem Sets: Chapter 10 Rotational Motion and Angular Momentum, and assigned problems

Week 5 Physics of Fluids and Gases

Session 5.1: Fluid Statics



Students will state the common phases of matter, explaining their physical characteristics and arrangements of atoms. They will define and calculate density, comparing densities of different substances. Students will also describe pressure and explain the relationship between pressure and force, and variation of pressure with fluid depth. They will define pressure in the context of Pascal's principle and its applications. Students will differentiate gauge pressure from absolute pressure and explain how barometers work. They will explore buoyancy and Archimedes' principle, understanding why some objects float while others sink.

Readings and Problem Sets: Chapter 11 Fluid Statics and assigned problems

Lab 5.1 Work and Energy (Experiment 12)

Students will apply concepts of work and energy in the laboratory. The conservation of energy will be used to study the relationship between work and energy for cars rolling up and down an inclined plane. After performing the experiment, students will explain how work and energy are related, describe how frictional work can be measured using energy, and better appreciate the nonconservative aspects of real situations. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Session 5.2 Fluid Dynamics

Students will calculate flow rate, define units of volume, describe incompressible fluids and explain the consequences of the equation of continuity. They will also explain Bernoulli's equation, calculate Bernoulli's principle and describe its applications. Students will then explore fluid dynamics in biological and medical applications, including blood flow but also molecular transport phenomena, like diffusion, osmosis and related processes.

Readings and Problem Sets: Chapter 12 Fluid Dynamics and Its Biological and Medical Applications, and assigned problems

Lab 5.2 Archimedes' Principle: Buoyancy and Density (Experiment 21)

Students will explore why some objects float and others sink using Archimedes' principle, that the upward buoyant force acting on a floating object is equal to the weight of the fluid it displaces, and an object will sink if its weight exceeds that of the fluid it displaces. After completing the experiment, students will be able to tell whether an object will float or sink, distinguish between density and specific gravity, and describe how the density of objects that sink or float may be determined experimentally. A prelab quiz and post-lab notebook check will be graded.

Session 5.3 Temperature, Kinetic Theory and Gas Laws

Students will define temperature and will convert temperatures between Celsius, Fahrenheit and Kelvin. They will describe thermal equilibrium and the 0th Law of Thermodynamics. They will go on to explore thermal expansion of solids and

liquids, the Ideal Gas Law and will use Avogadro's number to explain pressure, temperature and volume change.

Readings and Problem Sets: Chapter 13 Temperature, Kinetic Theory and Gas Laws, and assigned problems [1]
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Week 6 Heat and Thermodynamics

Session 6.1 Heat and Heat Transfer

Students will understand heat in terms of transfer of energy. They will observe how this changes temperature, mass and can impact phase change and latent heat. Students will explore heat transfer methods, like conduction, convection and radiation. For each, students will apply different means of heat transfer to their daily lives.

Readings and Problem Sets: Chapter 14 Heat and Heat Transfer Methods, and assigned problems

Lab 6.1 Thermal Coefficient of Linear Expansion (Experiment 19)

Students will find that solids generally increase in size with temperature, and that expansion depends on the internal structure of the object. Heating and cooling objects in this laboratory will allow students to tell how the thermal coefficient of linear expansion describes the relationship between expansion and temperature, explain how the linear thermal coefficient is measured and describe how this relationship can be applied to actual situation. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period. The lab will conclude with a thorough laboratory clean up.

Session 6.2 Thermodynamics

Students will describe the 1st Law of Thermodynamics, apply it to everyday situations and calculate changes in the internal energy of a system. They will then move onto the 2nd Law of Thermodynamics, using it to calculate efficiency and carbon dioxide emission of a coal fueled electrical plant and a nuclear reactor. They will then explore applications of thermodynamics to heat pumps and refrigerators. Students will then use the 2nd Law of Thermodynamics to entropy with processes both reversible and not. They will calculate the increasing disorder of a system and apply statistical probabilities to identify possibilities of entropy.

Readings and Problem Sets: Chapter 15 Thermodynamics, and assigned problems

Lab 6.2 Group Presentations of Physics in Daily Life (with demonstration experiment) Using principles of Physics, a thorough literature search online and personal interviews with local people, groups will present how on aspect of Physics impacts their lives and the lives of local people. This will include a



Physics demonstration of some kind. Students will be given a group and individual grade on their presentation.

Session 6.3 Comprehensive Review, Problem Set Workshop and Final Exam

Course Materials

Textbooks

Physics, 2015 Edition by Urone, P.P. et al. OpenStax College
<https://openstax.org/details/college-physics>

Physics Laboratory Experiments, Eighth Edition. 2014. J.D. Wilson and C.A. Hernández-Hall, Cengage Learning: Stamford, CT

Readings

Burko, L.M., 2018. Unveiling nonsense to save physics. *The Physics Teacher*, 56(1), pp.4-4.

Cronjé, F., 2013. Science, Technology and Society. *South African Review of Sociology*, 44(1), pp.180-198.

Czerski, H. 2018. Storm in a Teacup: The Physics of Everyday Life. W.W. Norton & Company.

Hermans, J and W. Drenckhan. 2013. Physics in Daily Life. Gallimard, Ltd.

Scherr, R.E. and Robertson, A.D., 2017. Unveiling Privilege to Broaden Participation. *The Physics Teacher*, 55(7), pp.394-397.

Wilczek, F., 2004. Whence the force of $F = ma$? I: culture shock. *Physics Today*, 57(10), pp.11-12.

Online Resources

Helen Czerrsi, The fascinating physics of everyday life, TED TALKS
https://www.ted.com/talks/helen_czerski_fun_home_experiments_that_teach_you_physics

Physics Student Resources. 2018. Openstax. Rice University
<https://openstax.org/details/books/college-physics#student-resources-section>