South Plains College
Common Course Syllabus: PHYS 2425
Revised 01/07/2020

Department: Science

Discipline: Physics

Course Number: PHYS 2425

Course Title: Principles of Physics I

Available Formats: conventional

Campuses: Levelland

Instructor:
David Hobbs
Office: S117D
Office Hours: MW 9:00 – 10:30 am, TT 8:00 – 9:00 am, F 8:00 – 11:00 am
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Course Description: Fundamental principles of physics, using calculus, for science, computer science, and engineering majors; the principles and applications of classical mechanics, including harmonic motion, physical systems and thermodynamics; and emphasis on problem solving. Basic laboratory experiments supporting theoretical principles and applications of classical mechanics, including harmonic motion and physical systems; experimental design, data collection and analysis, and preparation of laboratory reports.

Prerequisite: MATH 2413 Calculus I

Credit: 4 **Lecture:** 3 **Lab:** 3

Textbook: Matter & Interactions, 4th Edition (e-text through *Perusall.com* required, paper copy is optional)

Supplies: Scientific Calculator

This course partially satisfies a Core Curriculum Requirement:
Life and Physical Sciences Foundational Component Area (030)

Core Curriculum Objectives addressed:
- **Communications skills**—to include effective written, oral and visual communication
- **Critical thinking skills**—to include creative thinking, innovation, inquiry, and analysis, evaluation and synthesis of information
- **Empirical and quantitative competency skills**—to manipulate and analyze numerical data or observable facts resulting in informed conclusions
- **Teamwork**—to include the ability to consider different points of view and to work effectively with others to support a shared purpose or goal

Student Learning Outcomes:
Lecture Learning Outcomes - Upon successful completion of this course, students will:
1. Determine the components of linear motion (displacement, velocity, and acceleration), and especially motion under conditions of constant acceleration.
2. Solve problems involving forces and work.

3. Apply Newton's laws to physical problems.
4. Identify the different types of energy.
5. Solve problems using principles of conservation of energy.
6. Define the principles of impulse, momentum, and collisions.
7. Use principles of impulse and momentum to solve problems.
8. Determine the location of the center of mass and center of rotation for rigid bodies in motion.
9. Discuss rotational kinematics and dynamics and the relationship between linear and rotational motion.
10. Solve problems involving rotational and linear motion.
11. Define equilibrium, including the different types of equilibrium.
12. Discuss simple harmonic motion and its application to real-world problems.
13. Solve problems involving the First and Second Laws of Thermodynamics.

Lab Learning Outcomes - Upon successful completion of this course, students will:

1. Prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner.
2. Conduct basic laboratory experiments involving classical mechanics.
3. Relate physical observations and measurements involving classical mechanics to theoretical principles.
4. Evaluate the accuracy of physical measurements and the potential sources of error in the measurements.
5. Design fundamental experiments involving principles of classical mechanics.
6. Identify appropriate sources of information for conducting laboratory experiments involving classical mechanics.

Student Learning Outcomes Assessment: A midterm exam and a final exam will be administered to assess how well students have grasped the fundamental principles studied and their ability to apply those principles in new contexts.

Course Evaluation: Student grades will be based on reading assignments, weekly homework assignments, lab work, a semester project, a midterm exam, and a final exam. Final grades will be assigned based on overall, weighted average using the weighting scheme shown below:

Weighting Scheme		
Task	Code	Weight
Reading	R	10%
Homework	H	20%
Lab	L	20%
Semester Project	P	10%
Midterm	M	20%
Final	F	20%

The letter grades will be based on a fixed scale as follows:

A: 89.5 – 100 B: 79.5 – 89.5 C: 69.5 – 79.5 D: 59.5 – 69.5 F: below 59.5

Borderline cases (grades within 0.5 points of the break point) will be decided based on class attendance and participation.

Attendance Policy: Attendance and effort are vital to success in this course. Class attendance keeps you well connected to the course, so that you know at all times what's going on, what are the most important points, etc., and gives you opportunities to ask questions and clear up confusions. Therefore, students are expected to be in attendance for every class session. A student missing any part of the lecture or lab (including arriving late or leaving early) for a given class session may be considered absent. Students absent five times during the semester will be dropped from the class with an X (if passing at the time of the fifth absence) or F (if failing at the time of the fifth absence). It is the student's responsibility to keep track of how many absences they have. In-class work missed can be made up for the student's first two absences if the student can supply documentation showing the absence is excusable. Make-up work must be completed by the end of the week following the week in which the absence occurred. Any make-up work requiring use of the lab must be done on Friday mornings before 11:30 am.

Plagiarism and Cheating: Students are expected to do their own work on all projects, quizzes, assignments, examinations, and papers. Failure to comply with this policy will result in an F (grade of zero) for the assignment and can result in an F for the course if circumstances warrant.

Plagiarism violations include, but are not limited to, the following:

1. Turning in a paper that has been purchased, borrowed, or downloaded from another student, an online term paper site, or a mail order term paper mill;
2. Cutting and pasting together information from books, articles, other papers, or online sites without providing proper documentation;
3. Using direct quotations (three or more words) from a source without showing them to be direct quotations and citing them; or
4. Missing in-text citations.

Cheating violations include, but are not limited to, the following:

1. Obtaining an examination by stealing or collusion;
2. Discovering the content of an examination before it is given;
3. Using an unauthorized source of information (notes, textbook, text messaging, internet, apps) during an examination, quiz, or homework assignment;
4. Entering an office or building to obtain unfair advantage;
5. Taking an examination for another;
6. Altering grade records;
7. Copying another's work during an examination or on a homework assignment;
8. Rewriting another student's work in Peer Editing so that the writing is no longer the original student's;
9. Taking pictures of a test, test answers, or someone else's paper.

Student Code of Conduct Policy: Any successful learning experience requires mutual respect on the part of the student and the instructor. Neither instructor nor student should be subject to others' behavior that is rude, disruptive, intimidating, aggressive, or demeaning**.** Student conduct that disrupts the learning process or is deemed disrespectful or threatening shall not be tolerated and may lead to disciplinary action and/or removal from class.

Diversity Statement: In this class, the teacher will establish and support an environment that values and nurtures individual and group differences and encourages engagement and interaction. Understanding and respecting multiple experiences and perspectives will serve to challenge and stimulate all of us to learn about others, about the larger world and about ourselves. By promoting diversity and intellectual exchange, we will not only mirror society as it is, but also model society as it should and can be.

Disability Statement: Students with disabilities, including but not limited to physical, psychiatric, or learning disabilities, who wish to request accommodations in this class should notify the Disability Services Office early in the semester so that the appropriate arrangements may be made. In accordance with federal law, a student requesting accommodations must provide acceptable documentation of his/her disability to the Disability Services Office. For more information, call or visit the Disability Services Office at Levelland (Student Health & Wellness Office) 806-716-2577, Reese Center (Building 8) 806-716-4675, or Plainview Center (Main Office) 806-716-4302 or 806-296-9611.

Nondiscrimination Policy: South Plains College does not discriminate on the basis of race, color, national origin, sex, disability or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Vice President for Student Affairs, South Plains College, 1401 College Avenue, Box 5, Levelland, TX 79336. Phone number 806-716-2360.

Title IX Pregnancy Accommodations Statement: If you are pregnant, or have given birth within six months, Under Title IX you have a right to reasonable accommodations to help continue your education. To activate accommodations you must submit a Title IX pregnancy accommodations request, along with specific medical documentation, to the Director of Health and Wellness. Once approved, notification will be sent to the student and instructors. It is the student's responsibility to work with the instructor to arrange accommodations. Contact the Director of Health and Wellness at 806-716-2362 or email cgilster@southplainscollege.edu for assistance.

Note: The instructor reserves the right to modify the course syllabus and policies, as well as notify students of any changes, at any point during the semester.

Physics 2425 Principles of Physics I

Instructor

David Hobbs
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Course Description

Textbook

The textbook is *Matter & Interactions, 4th edition* by R. Chabay and B. Sherwood (John Wiley & Sons, 2015). Textbook Errata are at http://matterandinteractions.org/errata/.

Course Overview

In this course we will be examining the nature of matter and its interactions. The variety of phenomena that we will be able to explain and understand is very wide, ranging from the orbit of a planet to the speed of sound in a solid. The ***main goal*** of the course is to have you engage in a process central to science: ***modeling a broad range of physical phenomena using a small set of powerful fundamental principles***.

Approach

The course will emphasize rigorous problem-solving in physics using a student-centered active learning environment. Class sessions will require students to be responsive, to think, and to perform hands-on tasks. Key concepts of new material will be discussed in short lectures. Lab time will be interspersed with classroom discussion. If you devote a sufficient amount of time each day to studying physics, you will be in a position to attack physics problems efficiently, based on a clear understanding of the fundamental physical principles that underlie all successful analyses.

Collaborative Work

This course encourages collaborative teamwork, a skill that is valued by most employers. As you study together, help your partners to get over confusions, ask each other questions, and critique each other's homework write-ups. Teach each other! You can learn a great deal by teaching. But remember that you are responsible for understanding all details of a problem solution.

Study requirements

In addition to your time in class each week, you are expected to spend about 10 hours studying outside of class. If you typically spend less than 8 hours in outside study, you are unlikely to be able to learn the material. Less well prepared students may find they need to spend even more time than this. If you typically spend more than 12 hours in outside study, it is extremely important that you consult with me about ways to study more efficiently.

It is important to keep up with the class. New concepts introduced in this course build on earlier ones, so mastering key concepts is critical. If you get behind, seek help right away!

Assignments

Readings in Perusall

Perusall is a collaborative reading and annotation tool which turns reading assignments from an isolated solitary activity into an engaging collective social interaction. While reading your text in Perusall you can highlight a selection and ask a question or post a comment which will start a new discussion thread; you can also add a reply or comment to an existing thread. Each thread is like a chat with one or more of your classmates. This collaborative questioning and answering helps you master readings faster, understand the material better, and get more out of your physics class. For more information see the handout "How Perusall Works". As you read the text, you should work each checkpoint question and keep these in your course portfolio – see below.

Homework

Homework will consist of five or six problems each week requiring detailed written solutions. Writing good solutions provides practice in communicating your thinking process in a clear and precise way. Engineers (as well as professionals in other technical areas) actually spend a significant amount of time communicating their ideas in a way that is comprehensible to others. Being able to write clearly is an important skill for an engineer. You will also find that writing good explanations of your thinking process will improve your understanding of the physics concepts you are studying. Communicating your thinking process on paper will require writing sentences and paragraphs in addition to equations and formulas. A well written solution will include verbal explanation stating what physics principles are used, appropriate well-labeled diagrams, symbolic solution before numerical values are substituted, and correct numerical result with correct number of significant figures and correct units. Students whose work is excessively messy or poorly explained will be asked to rewrite the assignment.

Course Portfolio

You will maintain all your course work in a three-ring binder. The binder must have separate sections for your checkpoint solutions, in-class problem solutions, written homework solutions, and lab work. You may also include sections for your reading notes and class notes if you want. These materials may be collected for inspection at any time. Please make certain that you keep your portfolio up-to-date and bring it with you to every class meeting and when seeking help during office hours. Maintaining a well-organized, up-to-date portfolio will provide you an extremely useful tool for reviewing before exams.

Getting help with assignments

You should ask lots of questions in class to clear up any initial confusion you might have about a topic. I also encourage you to avail yourself of my help during office hours. You do not have to wait for my official office hours to get help; anytime I am in my office you are always welcome to come get help. If you fall behind for any reason, please let me know as soon as possible. The sooner I know about these situations, the better I can help you make up work. I will do what I can to help you complete the course satisfactorily.

Laboratory

During lab you will typically work in groups of three students on the following three kinds of activities:

- Experiments, involving measurement and analysis of data according to fundamental principles.
- Computer modeling, involving constructing 3-D models of physical systems and their motion. This will involve the VPython programming language. No previous programming experience is needed – I will teach you the basic concepts needed. Some computer modeling activities may need to be finished outside of class.
- Group problem solving, involving work on large, complex problems. In lab you may begin work on a large problem to be completed outside class or the entire problem may be solved during class.

Semester Project

Semester projects will be chosen in consultation with the instructor. Possibilities include numerical simulations that expand beyond what we do in lab, an experimental project carried out and reported by the student, extended analysis of a challenging, more realistic problem to demonstrate application of fundamental physics principles, or some other creative project you get approved as long as it demonstrates mastery of the basic physics principles studied. You must decide on your project and have it approved by the instructor before the midterm exam. A first draft of your project report will be due four weeks after the midterm exam. Final project reports will be due the week before the final exam.

Exams

Midterm exam

A single midterm exam will be given approximately half way through the semester. The date of the exam is shown on the course calendar. The exam will be closed-book, but some relevant formulas and constants will be provided. If you have an excused absence, you will need to contact me to make up the missed exam.

Final exam

A comprehensive final exam will cover all of the course material. The final exam will be closed-book, but some relevant formulas and constants will be provided. It will be given during the scheduled final exam time as shown in the schedule of classes and on the course calendar.

Specific Course Objectives

Learning objectives students should achieve to successfully complete this course:

1. Apply the <u>momentum principle</u> (Newton's second law of motion) to analyze and predict the future motion of a system subject to a net force (constant or varying).
2. Use the <u>momentum principle</u> stated in any of its various forms (update, conservation, and instantaneous form) to model the interactions of both simple and complicated systems with their surroundings.
3. Give examples of each of the fundamental interactions, recognizing which fundamental interaction is responsible for the forces acting between a system and its surroundings. In the case of gravitational and electrical interactions, calculate the forces between interacting particles.
4. Discuss how contact forces (tension, compression, and friction) can be modeled based on the internal atomic structure of solids, including determining appropriate values for the interatomic spacing and interatomic bond stiffness. Relate these microscopic properties to measureable macroscopic properties such as Young's modulus.
5. Apply the <u>energy principle</u> to analyze the transformations of energy within a system (including kinetic energy, potential energy, and rest energy) and the transfers of energy between a system and its surroundings (including work, energy transferred due to a temperature difference, and other energy transfers).

6. Distinguish between the overall mechanical energy of a large multiparticle system and its internal energy. Use specific heat to relate changes in a system's internal thermal energy to changes in its temperature.
7. Apply the energy principle to the quantized electronic, vibrational, and rotational energies of atoms and molecules, including their interactions with their surroundings by emission and absorption of photons and collisions with energetic electrons.
8. Use the momentum and energy principles together to analyze how interactions of an extended system (rigid or deformable) with its surroundings change the energies and motions of the system.
9. Use the momentum and energy principles together to analyze elastic and inelastic collisions (both head-on and scattering collisions) at speeds small compared to the speed of light and at relativistic speeds.
10. Apply the angular momentum principle in both the update and conservation forms to analyze the motions of systems subject to both nonzero and zero net torques.
11. Combine the momentum principle, energy principle, and angular momentum principle to analyze extended systems interacting with their surroundings to find changes in the system's energies and motions.
12. Apply the fundamental assumption of statistical mechanics to the Einstein model of a solid to determine the most likely energy distribution between two interacting systems, relating this to the definition of entropy and the second law of thermodynamics.
13. Calculate a system's temperature in terms of rate of change of entropy with internal energy and discuss why thermal equilibrium of two systems occurs when they have the same temperature.
14. Calculate the dependence of heat capacity on temperature using the Einstein model of a solid.

Calendar

Phys 2425.001 Spring 2020

Week	Tuesday Readings	Tuesday Topics	Thursday Readings	Thursday Topics
1	01/14	Course Introduction; *Perusall* Registration	01/16 **1.1 – 1.5**	Detecting Interactions: Newton's 1st Law; Vectors Lab – VP01: Intro to Computational Modeling
2	01/21 **1.6 – 1.7**	Velocity; Position Update Equation; Acceleration Lab – Motion of a Fan Cart on a Track	01/23 **1.8 – 1.11**	Momentum; Change in Momentum; Using Momentum to Update Position Lab – VP02: Computational Models of Motion 1
3	01/28 **2.1 – 2.4**	The Momentum Principle (Newton's 2nd Law); Iteratively Predicting Motion – Constant Net Force Lab – Momentum Change of a Fan Cart	01/30 **2.5 – 2.7**	Analytical Prediction of Motion – Constant Net Force; Iteratively Predicting Motion – Varying Net Force Lab – VP03: Computational Models of Motion 2
4	02/04 **3.1 – 3.6**	Fundamental Interactions; Gravitational Force; Reciprocity (Newton's 3rd Law); Predicting the Motion of Gravitationally Interacting Objects Lab – VP04: Calculating Gravitational Force	02/06 **3.7 – 3.12**	Electric Force; Strong and Weak Interactions; Momentum Principle for Multiparticle Systems; Momentum Conservation; Collisions Lab – VP05: A Space Voyage Part 1
5	02/11 **4.1 – 4.8**	Atomic Model of Contact Interactions: Tension Forces, Normal Forces, Frictional Forces Lab – VP06: A Space Voyage Part 2	02/13 **4.9 – 4.14**	Speed of Sound in a Solid; Derivative Form of the Momentum Principle; Analytical Solution for a Spring-Mass System; Buoyancy Lab – Measuring Young's Modulus
6	02/18 **5.1 – 5.5**	Determining Unknown Forces Using the Derivative Form of the Momentum Principle Lab – Determining Spring Stiffness	02/20 **5.6 – 5.10**	Applying the Derivative Form of the Momentum Principle to Curving Motion Lab – Mass/Spring Oscillator
7	02/25 **6.1 – 6.5**	The Energy Principle applied to a Single Particle System Lab – VP07: Spring/Mass Model Part 1	02/27 **6.7 – 6.9**	The Energy Principle applied to Multiparticle Systems; Gravitational Potential Energy; Electric Potential Energy Lab – Problem Solving
8	03/03 **6.10 – 6.14**	Energy Graphs; Mass of Multiparticle Systems; Binding Energy; Choosing Initial and Final States Lab – Problem Solving	03/05	**Mid-Term Exam**
9	03/10 **7.1 – 7.4**	Elastic Potential Energy of a Spring; Potential Energy of Interacting Neutral Atoms; Internal Energy; Specific Heat Lab – VP08: A Space Voyage Part 3	03/12 **7.5 – 7.10**	Energy Principle applied to Large Multiparticle Systems; Microscopic Work (Heat Transfer); Energy Accounting; Energy Dissipation Lab – VP09: Spring/Mass Model Part 2
10	03/17	Spring Break – No Class	03/19	Spring Break – No Class
11	03/24 **8.1 – 8.3**	Energy Quantization – Electronic Energy Levels; Emission and Absorption Spectra Lab – Running Up Stairs	03/26 **8.4 – 8.10**	Energy Quantization – Vibrational and Rotational Energy Levels Lab – Atomic and Molecular Spectra
12	03/31 **9.1 – 9.2**	Separation of Kinetic Energy in Multiparticle Systems into Translational, Rotational, and Vibrational Kinetic Energy; Moment of Inertia Lab – Problem Solving	04/02 **9.3 – 9.4**	Modeling a System as a Point Particle and Modeling a System as an Extended Object; Detailed Model of Friction Lab – Jumping upward
13	04/07 **10.1 – 10.6**	Collisions – Applying both Momentum and Energy Principles Together Lab – Problem Solving	04/09 **10.7 – 10.12**	Rutherford's Discovery of the Nucleus; Relativistic Particle Collisions Lab – VP10: Rutherford Scattering Model
14	04/14 **11.1 – 11.6**	Angular Momentum and the Angular Momentum Principle Lab – Problem Solving	04/16 **11.7 – 11.10**	Combining All Three Fundamental Principles in Problem Solving Lab – Torque and Angular Momentum Change
15	04/21 **11.11 – 11.12**	Angular Momentum Quantization; Gyroscopic Motion Lab – Problem Solving	04/23 **12.1 – 12.4, 12.7**	Fundamental Assumption of Statistical Mechanics; Entropy and the Second Law of Thermodynamics Lab – VP11: Statistical Mechanics Part 1
16	04/28 **12.5 – 12.7**	Definition of Temperature ; Predicting the Specific Heat Capacity of Solids Lab – VP12: Statistical Mechanics Part 2	04/30 **12.8 – 12.9**	The Boltzmann Distribution
17	05/05		05/07	**Final Exam – 8:00 to 10:00 am**