Independent Study in Idaho

Phys 1100

Essentials of Physics

Providing independent study opportunities for more than 40 years.

Course Guide

Independent Study in Idaho

Self-paced study. Anytime. Anywhere!

Physics 1100
Essentials of Physics

Idaho State University
4 Semester-Hour Credits

Prepared by:
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Idaho State University

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3-Phys 1100

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Phys 1100: Essentials of Physics 4 credits: ISU

Welcome

Whether you are a new or returning student, welcome to the Independent Study in Idaho (ISI) program. Below, you will find information pertinent to your course including the course description, course materials, course objectives, as well as information about assignments, exams, and grading.

Policies and Procedures

Refer to the ISI website at **www.uidaho.edu/isi** and select *About ISI Policies* for the most current policies, procedures, and course information, including information on setting up your accounts, exams and proctors, grades and transcripts, course exchanges and the refund schedule, library resources and other services, academic integrity, and disability support services. If you have any questions or concerns, please contact the ISI office for clarification before beginning your course.

Course Description

A survey of basic physics principles; motion, gravitation, electricity and magnetism, light, atoms, and nuclei. Includes lecture, demonstrations and elementary problem-solving. ISU students: Partially satisfies Objective 5 of the General Education Requirements. COREQ: MATH 1108 or equivalent. F, S.

Required: Internet access – this course cannot be completed without access to the Internet

11 graded assignments, 2 proctored exams

Course Materials

Required Course Materials

Hewitt, Paul G. Conceptual Physics. 11th Ed. Addison-Wesley, 2009. ISBN-10: 0-321-56809-5 / ISBN-13: 978-0-321-56809-0

Recommended Course Materials

Hewitt, Paul G. *The Practice Book for Conceptual Physics*. 11th Ed. Addison-Wesley, 2009. ISBN- 978-0-321-66256-9

Course Delivery

All ISI courses are delivered through Canvas, an online management system that hosts the course lessons and assignments and other items that are essential to the course, including instructor contact information. Refer to your *Registration Confirmation Email* for instructions on how to access Canvas.

Course Introduction

Physics is a science course concerned with the properties of motion, matter, and energy. This course focuses on mechanics, solids and fluids, thermodynamics, waves and sound, electrostatics and magnetism, light, and the structure of the atom.

This course is designed for students who typically have little scientific background. No formal knowledge of physical science is required. A working knowledge of high school algebra, however, is assumed. You will need a calculator, which can handle scientific notation. The mathematics we use in this text goes no farther than high school math and algebra. Mathematics is a powerful tool for expressing the quantitative relationships of physics. This text has done well in minimizing the use of mathematics; it has retained the logical coherence necessary to adequately introduce physics.

Course Objectives

To understand the basic principles of Physics and the scientific method. To help you develop an understanding of the physics observed around you. You will learn the contributions of many physicists that have discovered the fundamental laws and principles of physics. To accomplish these goals, concepts are developed concerning common, everyday experiences, and there are references to simulations and videos that demonstrate these physics principles

Grading

The course grade will be based upon the following considerations:

There are eleven graded lessons, two self-study lessons, and two exams. The average of your lesson scores (except the self-study) will count as 60% of the grade. Each exam will count as 20% (40% total).

Grades will be assigned according to the following schedule:

93 – 100% = A	73 – 76.9% = C
90 – 92.9% = A-	70 – 72.9% = C-
87 – 89.9% = B+	67 – 69.9% = D+
83 – 86.9% = B	63 – 66.9% = D
80 – 82.9% = B-	60 – 62.9% = D-
77 – 79.9% = C+	Below 60 = F

The final course grade is issued after all lessons and exams have been graded.

Acts of academic dishonesty, including cheating or plagiarism, are considered a serious transgression and may result in a grade of F for the course.

About the Course Developer

Dr. Bryan Barclay grew up on a dairy farm in South Eastern Idaho. He received a bachelor's degree in mechanical engineering from Brigham Young University, then worked for Boeing Commercial Airline Company, in Everett, Washington. While at Boeing he earned a master's degree in physics at the University of Washington.

After Boeing, he worked for Morton-Thiokol in Utah. Two years later, he began his teaching career at Salt Lake Community College. In another two years, he went back to graduate school and earned a Ph.D., in physics from Utah State University (USU) in 2001. While working on his doctorate, he taught math and physics part time for USU and Weber State University. He is currently teaching physics and math for the College of Technology at Idaho State University. His research involves astrophysics, and the title of his dissertation is "Probing Void Structure Using Galaxy Number Count Techniques." He enjoys camping, bike riding, and playing his banjo. He is married and has three kids.

Contacting Your Instructor

Instructor contact information is posted on your Canvas site.

Assignment Submission Log

Use this log to help you keep track of your progress through the course.

Lesson	Date Submitted	Grade	Total Points
1			
2			
3			
4			
5			
Self-Study			
It is time to take Exam 1.			
Exam 1			
7			
8			
9			
10			
11			
12			
Self-Study			
It is time to take Exam 2.			
Exam 2			

Lesson 1
Galilean Mechanics

Lesson Objectives

- Get to know some of the basic questions and the individuals that endeavored to answer these questions that lead to the emergence of Physics as a science that describes natural motion in our environment.
- Understand Inertia and equilibrium.
- Learn the definitions of Speed, Velocity, and Acceleration.
- Understand the nature of a vector quantity

Reading Assignment

Chapters 1 – 3.

Important Terms

Erastosthenes	Newton's first Law of Motion	Vector
Aristotle	Net force	Scalar
Copernicus	Mechanical equilibrium	Acceleration
Galileo	Equilibrium Rule	Free Fall
Isaac Newton	Speed	
Inertia	Velocity	

Lecture

Chapter 1 introduces the techniques used by early philosophers to determine key quantities about our environment. Erastothenes (235 BC) used a clever method to determine the circumference of the Earth. Even though he didn't have sophisticated measurement tools, he was able to determine this circumference quite accurately. He was able to determine the Earth's radius is 6370 km. Another important, and early, discovery is the average distance to the Sun is 93,000,000 miles or 150,000,000 km. Other key discoveries were distance to the moon, the moon's diameter, and the Sun's size.

Chapter 1 also discusses the integration of mathematics and science. On some occasions, new mathematics techniques were developed to solve Physics problems. We are also cautioned to be wary of pseudoscience, a fake science that usually cannot be tested or consistently verified through experimentation. Physics is the basic science that is about the basic nature of motion, energy, matter, heat, sound, light, etc.

Most of the measurements and quantities we will discuss in this course will be metric such as kilometers, kilograms, meters, Newtons, etc.

It is interesting to study some of the main characters that were involved in the development of Physics. Usually, they were court philosophers that were censored by ecclesiastical authority, yet were tenacious about their ideas and discoveries. One of the first was Aristotle. He considered everything to be part of 4 elements; Earth, air, fire, and water. He explained that a falling rock was merely trying to return to its natural state as part of the Earth. Smoke was part air and fire. Things that rose or fell were exhibiting natural motion. Those that moved sideways or erratically were in violent motion (such as the motion of an arrow through the air). Although Aristotle was wrong, he created an awareness that there may be natural laws that can lead to the prediction of motions and actions. Copernicus was a major contributor to the advancement of orbital mechanics. He proposed that the planets orbited the Sun (Heliocentric system – Sun-centered), which meant that the Earth must move! This was against all accepted understanding at the time and would have led to great persecutions. However, he died the day his book was published (De Revolutionibus). Galileo came next. He had a very assertive personality and insisted that Copernicus was correct. Although he had friends in the courts, he soon ran afoul of the authorities, of the time, and was forced to recant his ideas, and he spent the end of his life under house arrest. Even while under arrest, he smuggled some of his work out and had it published in Italian, which was forbidden at the time. This meant that the common citizen had access to academic knowledge that, until then, was only understood by nobles that read Latin.

Galileo's work was very pivotal and eventually led to the development of Mechanics. Mechanics is the part of Physics that deals with the basic motion of objects and forces. He devised and conducted experiments that could prove his hypothesis. One of his greatest contributions was his hypotheses of the inclined planes discussed on page 22. He determined that if the incline starts down then turns up; a ball will roll to the same height it began. This happened regardless of how long the lower or flat part is. Most of these ideas presume very little or no friction. Therefore, if the incline never comes back up, the ball should roll endlessly. He called this tendency for an object in motion, to stay in motion in a straight line, at constant speed; 'Inertia'. Inertia is the name he gave to this property of materials. The reason you can pull a cloth out from underneath an object without moving the object is because the object has inertia. This means Inertia tends to keep stationary objects from moving (see: http://www.youtube.com/watch?feature=player_embedded&v=--MDILG7Znk and http://www.youtube.com/watch?v=JIwcPhjDdpY). Possibly Galileo's most famous experiment was dropping objects of different sizes off the leaning tower of Pisa. This led to the understanding that all falling objects (in the absence of air resistance) will fall with the same acceleration.

Later, Sir Isaac Newton made a restatement of the Law of Inertia as his 1st Law of Motion (see page 23). He understood the reason a moving object eventually comes to rest is that there is an external force acting on it, i.e., friction and that the natural motion of an object is to continue the way it is moving (at a constant speed).

Friction is one of many types of forces. Forces are vector quantities. A vector is a physical property that also depends on direction. We will deal with many vector quantities in this course; such as velocity, momentum, and acceleration. Quantities that do not depend on direction, such as mass, speed, and energy are called scalars. If I said 'a car was moving at 10 mph', that is a scalar speed. If I said 'it is moving at 10 mph North', then I have specified a direction, and it is now a velocity. One property of vectors is that they can be in opposite directions and cancel each other out. For example, if you push and pull on the same object the forces oppose each other because they are in opposite directions. Objects may be exposed to several forces at the same time. The net force is the result of the sum of several forces. If the net force is zero, no motion will occur.

On the top of page 26, you see three different scenarios of forces on bricks. The units for force are 'Newton's'. You see that if you have two 5 N forces in the same direction, they sum to 10 N of net force. If they are applied in opposite directions, there is no net force. If they are in opposite directions and one force is greater than the other, you would subtract one force from the other, and the net force will be in the direction of the larger force. The text and I don't always indicate a direction. If it is a vector quantity (vector quantities will be in bold) usually the convention is that, if it is positive, it is to the right, negative, left.

The equilibrium rule is that for an object to be in equilibrium, the sum of all forces must be zero (i.e., $\Sigma F = 0$). One example of equilibrium is support forces. While you stand on the ground, you are attracted to the center of the Earth by its gravity. The floor provides a support force equal to your weight upward. This support force is in the opposite direction of gravity, thus the two forces sum to zero. If they didn't, you would sink through the floor. When you stand on a scale it is reading the support force the spring must provide to hold you up. An object can be moving and be in equilibrium. To keep a crate moving across the floor, you need only apply a forward force equal to the friction. An object will continue to move at a constant velocity because of its inertia. Go to http://phet.colorado.edu/sims/lunar-lander/lunar-lander_en.html and play around with this simulation and see if you can get the lander to hover (stay at the same altitude). This would be a condition of equilibrium, where the upward thrust force equals the weight.

In chapter 3, make sure you know the definitions of velocity and acceleration. The units we will use for velocity is meters/second (m/s), for acceleration it will be m/s^2. It is important to be able to distinguish the difference between velocity and acceleration. We experience both every day. If there is no change in velocity you either remain at rest or move at a constant speed in a straight line. Since velocity is a vector, any change in speed or direction is a change in velocity. Since any change in velocity per unit time is the definition of acceleration, any change in speed or direction is an acceleration. Consequently, an object moving at a constant velocity has no acceleration.

To experiment with velocity (v) and acceleration (a), go to http://phet.colorado.edu/en/simulation/moving-man . After the simulation loads, click on 'charts', you will see graphs for position vs. time, velocity vs. time, and acceleration vs. time. Try several settings with velocities, then try some with velocities and accelerations in the same and opposite directions. When something accelerates, it moves further in successive time intervals. This is because the velocity is different at each time interval. The formula for the distance something goes (starting from rest) at a constant acceleration is $d = ½at^2$ (1). For example; How far will an object with $a = 2m/s^2$ move in 3 s. Using the formula (1); $d = ½ (2m/s^2) (3 s)^2$, the s^2 cancel, so the answer is 9 m. Another important equation that relates velocity and acceleration is $v = at$. With this formula, you can determine the velocity of an accelerating object at any time t after it starts.

Free fall is a natural system with constant acceleration. Free fall is defined as an object under the influence of gravity only. Thus we neglect air resistance. The acceleration of any object in free fall is the acceleration of gravity on the surface of the Earth, $g = 9.8\ m/s^2$. For ease of calculation, we round that up to $10\ m/s^2$.

Written Assignment

Submit the answers to the following questions:

1. Describe the motion of an object if no external forces are acting on it.
2. A sheet of paper can be pulled out from under a container of milk without toppling it if the paper is jerked quickly. What property does this demonstrate?
3. A hockey puck slides across the floor at a constant velocity. Is it in equilibrium? Explain your answer.
4. In the absence of air resistance, which will fall faster, a bowling ball or a beach ball of the same size?
5. What was Copernicus' model of the solar system?
6. From chapter one, what is the language of science?
7. If you divide velocity by acceleration (v/a) what would the units of the result (in metric) be?

8. What is the average speed of a horse runs a distance of 10 km in a time of 30 minutes?
9. It takes 6 seconds for a stone to fall to the bottom of a mine shaft. How deep is the shaft?
10. If a ball is moving upward at 50 m/s, (on a planet where g = 10m/s/s) what is its velocity 6 s later? In what direction?
11. An object speeds up from 20 m/s to 45 m/s in 5 s, what is its acceleration?
12. If an object moves with a constant velocity, what can you say about its acceleration?
13. From the first inertia video; describe how the instructor removed the hoop. Why did he do it that way?
14. Using the 'Moving Man' simulation, with a constant acceleration of 2 m/s^2, how long did it take the man to move between walls?
15. Using the 'Moving Man' simulation, how far does the man get when the velocity is 4 m/s, and the acceleration is $-12 m/s^2$?
16. Using the 'Lunar Lander' simulation, what is the highest altitude you can get to?
17. How far will an object fall in 5 seconds? What is its velocity if it fell from rest?
18. What happens when your acceleration is in the opposite direction as your velocity?
19. How did Aristotle explain the motion of the moon?
20. Assume you have a constant acceleration of 4 m/s^2, and object starts at rest at time t = 0. Copy and fill in the following table.

Time (s)	*Velocity (m/s)*	*Distance (m)*
0	*0*	*0*
1		
2		
5		
7		
10		