Core Curriculum Assessment Report
2011_12

Department Physics

Representative Dr. Chin-Che Tin

Course Name / number PHYS1500/1510

1. **AGSC Content Area of Alignment:** Area III: Science and Math

2. **SLO(s) being assessed: Student will..**

SLO 10: Students will understand and appreciate methods and issues of science and technology.

3. **Assessment Method(s):**

[Explain how assessment for the measures associated with this SLO - not grading for the course as a whole - was conducted. You my cut/paste rubics for inclusion here, identify faculty reviewing committees, or identify specific kinds of test questions important to your method. Is this the method you initially planned to use? Provide a separate paragraph for each method].

The assessment of these courses comes under the purview of the Physics Department's Learning Improvement Committee for Introductory Physics and Astronomy, chaired by Dr. Chin-Che Tin. The committee believes that learning assessment should not be viewed as a measure of the teaching effectiveness of the instructors. To discourage such unwarranted association and to encourage participation in the assessment efforts, the committee has decided not to identify the instructors. However, during the committee meetings to discuss assessment data, the instructors may choose to identify themselves to aid in the discussion, and many instructors did.Members of the Learning Improvement Committee for Introductory Physics and Astronomy were:Dr. Chin-Che Tin (Chair)Dr. Satoshi HinataDr. Stephen KnowltonDr. Stuart LochDr. Joseph PerezThe Chair of the committee has also invited other instructors also teaching these courses but who are not members of the committee, to the meetings.The department has identified the following assessment areas: homework problems, laboratory experiences, classroom interactive sessions, and test questions. Faculty may elect to use any or all of these assessment areas for learning assessment. However the department encourages all faculty teaching PHYS 1500/1510 to use MasteringPhysics, an online assignment program, as the primary assessment tool. Up to five problems are assigned throughout the semester that relate well to each of these five measures associated with SLO 10 and the performance of our students is compared to the National Average. Up to Fall 2011, the committee allowed instructors to choose their own set of problems even when more than one instructors are teaching the same course. The committee noted that it is most logical for all classes of the same course to use the same set of questions. Therefore, from Spring 2012 onward, instructors using MasteringPhysics are requested to use the same set of questions provided by the committee.For Spring 2012, we included data from laboratory experiments as well.Data were collected for both Fall 2011 and Spring 2012.The committee met on April 3, 2012, to discuss the assessment data for Fall 2011.The committee met again on September 27, 2012, to discuss the assessment data for Spring 2012.PHYS 1500Fall 2011:Instructor C taught both MWF and TR classes. Data were collected from both classes. The instructor chose tests as the mode of assessment. This is one of the methods accepted by the department for learning assessment. Spring 2012:In this semester, two different instructors C and D taught the course.Both instructors used MasteringPhysics online assignment as the mode of assessment. Both instructors chose questions from the common set of questions provided by the committee.PHYS 1510Fall 2011:This class was taught by Instructor D. Spring 2012:In this semester, three different instructors E, F, and G taught the course.All instructors used MasteringPhysics online assignment as the mode of assessment. All instructors chose questions from the common set of questions provided by the committee.

4. **Findings: What assessment data did each assessment method produce?**

For tests/exam, the data reported were the average % score of the class for each question.For online assignment using MasteringPhysics, the data collected were percentage of students completing the assigned problems (% Complete), average percentage score of those students completing the assigned problems (%

Average Score), and average percentage national score of students given the same problems in those institutions in the U.S. using MasteringPhysics (% National Score). The % National Score data are derived from a sample of several thousand students. PHYS 1500Fall 2011:Average score for MWF class: 79%Average score for TR class: 71.7%The average score for these two classes was 75% with the MWF class doing better than the TR class. This score of 79% is higher than typical test scores (~60%) in Introductory Physics in the Physics Department.Spring 2012:Instructor C :% Complete: 72.1% Average Score: 98.1% National Score: 91.5Instructor D:% Complete: 83.8% Average Score: 95.8% National Score: 91.5Both classes have comparable average scores which are higher than the national average score.Instructor D has a higher assignment completion rate (%Complete) than C.PHYS 1510Fall 2011:Instructor D:% Complete: 85.5% Average Score: 91.7% National Score: 91.5Completion rate is higher than usual and average score is comparable with the national average.Spring 2012:Instructor E:% Complete: 82.2% Average Score: 93.4% National Score: 93.8Instructor F:% Complete: 81.7% Average Score: 97.5% National Score: 93.8Instructor G:% Complete: 85.6% Average Score: 90.2% National Score: 93.8From the three classes, the average results are:% Complete: 83.2% Average Score: 93.7% National Score: 93.8The average completion rate is higher than in the past (~70-80%).The average score (93.7%) is comparable to the national average score (93.8%).

5. How did you (or will you) use the findings for improvement?

[What questions / issues / concerns did your data raise for the faculty teaching the course? What discussion did the faculty have about the findings? What future actions to improve student attainment of this outcome will the department / program take as a result of this analysis?]

Fall 2011:Instructor C should have used the same order of questions in his Fall 2011 assessment to allow more meaningful comparison between the MWF and TR classes for the same question.Spring 2012:Getting all the students to do the assignments is a problem. As in all other courses, motivation is an issue that instructors have to confront.Regular review is important and instructors should make use of recitation classes to provide review sessions.Instructor’s Verbatim Comments:(Instructor C for PHYS1500-Fall 2011)Students had the most difficulty with taking a concept or principle and applying it to other situations. They scored best on questions that were either the same or similar to ones they had seen in class. They scored poorly when a question required that they interpret the idea or concept in order to answer the concept correctly. Unfortunately in the time allotted for the course it would be difficult to correct this problem. Roughly 50% of class time is spent on concepts and making sure the students understood them. When doing problems students were required to think about the conceptual implications of the problems. Unfortunately many students either ignored, refused to do, or spent little effort on this part of the class. Several teaching techniques were employed including active learning and peer instruction, these produced mixed results and were often met with resistance by the students. The students rarely understand the difference between learning and memorization and will resist any attempt to engage them in the former and will try to force the instructor to adapt to their preferred method of memorization. Another large problem is preconceived notions of how the world works these are often hard to break and for some they refuse to believe it no matter what they are shown. For example Question 1 of Measure 5 was given as a question in class after student were to have read the section but before it was detailed in class. Students were then lectured on the topic, were given homework from multiple chapters that required knowledge of the fact, given a lab that showed graphically that it had to be true, quizzed on the subject, tested on the subject, and finally given the question on a test. Despite the importance given to this question they were still more than 10% of the class who failed to correctly answer the question and many other who answered correctly but failed accept and use the fact in their work.(Instructor G for PHYS1510-Spring 2012)Average score of all 5 measures was ~90%, which was an improvement from the previous year. The student turn out rate was ~80-90%. There were at least ~10% of students who didn't do the problems. To improve learning, I will make efforts to understand why some students didn't have time to do the homework.

6. Additional Comments:

[What else would you like the Committee to know about your assessment of this course or plans for the future?]

Instructors have academic freedom and therefore have the rights to use whatever questions or any assessment form they choose. They have the rights not to use the common set of questions suggested by the committee. It is therefore commendable that the Physics faculty agree to use a common set of questions for all classes of the same course. This is a major step forward in our assessment efforts. For Spring 2012, we included data from laboratory experiments. Using lab scores is more suitable for Measure 3.Problem still exists in finding proper questions to suit Measures 1 and 4.

7. Committee Comments

Mean of rubric score = 3.11 (out of 4)Questions allegedly assessing various measures, particularly Measure 2, have little to do with the associated measure(s)., hard to see correlations between questions and measuresSince questions don't relate to Measures, then no findings can logically emerge

PHYS 1500

General Physics I

PHYS 1500 – General Physics I
Fall 2011
Instructor C
Mode of Assessment: Tests

PHYS1500 Fall 2011 - MWF 8:00-8:50

Measure	Question	%
1	1	77
	2	89
	3	95
	4	92
	Average	88.3
2	1	80
	2	79
	3	99
	Average	86.0
3	1	52
	2	98
	3	74
	4	92
	5	90
	Average	81.2
4	1	73
	Average	73
5	1	85
	2	31
	3	68
	4	29
	5	88
	6	97
	Average	66.3
Overall Average		79.0

PHYS1500 Fall 2011 - TR 9:00-9:15

Measure	Question	%
1	1	11
	2	27
	3	95
	4	90
	Average	55.75
2	1	90
	2	81
	3	99
	Average	90
3	1	9
	2	97
	3	79
	4	90
	5	90
	Average	73
4	1	77
	Average	73
5	1	84
	2	48
	3	62
	4	67
	5	85
	6	54
	Average	66.7
Overall Average		71.7

Physics 1500 MWF 8:00-8:50am

Measure 1: Articulate the philosophical and historical foundations of modern science.

Question 1: Who was the first scientist to discover evidence to refute Aristotle's ideas?
Question 2: Who first deduced the relationship between radius and period?
Question 3: Which of Newton's Laws relates forces with the kinematic equations we learned in chapter 2?
Question 4: As physicists we will look at the ______ temperature scale.

Measure 2: Understand the scientific method and demonstrate an ability to apply it across a variety of situations.

Question 1: Which trig function allows us to calculate the component of a vector A along the y axis if we use a standard coordinate system?
Question 2: The conversion factor to go from m/s to mph is:
Question 3: How must vectors be positioned to add them?

Measure 3: Demonstrate an ability to conduct, and interpret the results of experiments aimed at better understanding natural phenomena.

Question 1: If you start with water at 20°C and ice at 0°C but end with just water how many terms do you need to add to your heat equation (Q = 0).
Question 2: The velocity is represented on a position vs. time graph as what?
Question 3: A graph of "a versus b" means a is graphed on the _________ axis.
Question 4: The area under the velocity graph during a time interval is what?
Question 5: Which type of graph would we use to find the impulse?

Measure 4: Understand major issues and problems facing modern science and technology, including issues related to ethics, cultural values, public policies, and the impact of human activity upon the planet.

Question 1: A nuclear power plant is an example of a _____.

Measure 5: Demonstrate knowledge in one area of science, including understanding its basic principles, laws, and theories.

Question 1: What is the acceleration of an object thrown upward at the top of its flight?
Question 2: If we have a push force acting on an object and it is not moving what is the value of static friction?
Question 3: A car is rolling over the top of a hill at constant speed v. At this instant, its normal force is
Question 4: Two boys of equal mass standing halfway to the edge on a turntable that is rotating at an angular speed. One then moves to the center and the other to the outer edge, the final angular speed is ____ the initial angular speed.
Question 5: If the speed of a particle is doubled what happens to its kinetic energy?
Question 6: If the net work done on an object is 0 what can be said about the ***velocity*** of the object?

Physics 1500 TR 8:00-9:15

Measure 1: Articulate the philosophical and historical foundations of modern science.

Question 1: Who was the first scientist to create laws that refuted Aristotle's ideas?
Question 2: Who decided the natural state of an object was to be at rest and needed a force to keep it moving?
Question 3: Which of Newton's Laws relates forces with the kinematic equations we learned in chapter 2?
Question 4: As physicists we will look at the ______ temperature scale.

Measure 2: Understand the scientific method and demonstrate an ability to apply it across a variety of situations.

Question 1: Which trig function allows us to calculate the component of a vector A along the x axis if we use a standard coordinate system?
Question 2: The conversion factor to go from m/s to mph is:
Question 3: How must vectors be positioned to add them?

Measure 3: Demonstrate an ability to conduct, and interpret the results of experiments aimed at better understanding natural phenomena.

Question 1: If you start with water at 20 degrees Celsius and ice at -10 degrees Celsius but end with just water how many terms do you need to add to your heat equation (Q = 0).
Question 2: The velocity is represented on a position vs. time graph as what?
Question 3: A graph of "a versus b" means b is graphed on the _________ axis.
Question 4: The area under the velocity graph during a time interval is what?
Question 5: Which type of graph would we use to find the impulse?

Measure 4: Understand major issues and problems facing modern science and technology, including issues related to ethics, cultural values, public policies, and the impact of human activity upon the planet.

Question 1: An air conditioner is an example of a _____.

Measure 5: Demonstrate knowledge in one area of science, including understanding its basic principles, laws, and theories.

Question 1: What is the acceleration of an object thrown upward at the top of its flight?
Question 2: If we have a push force acting on an object and it is not moving what is NEVER the value of static
Question 3: A car is rolling over the top of a hill at constant speed v. At this instant,
Question 4: Two boys of equal mass standing halfway to the edge on a turntable that is rotating at an angular speed. One then moves to the center and the other remains, the final angular speed is ____ the initial angular speed.
Question 5: If the speed of a particle is doubled what happens to its kinetic energy?
Question 6: If the net work done on an object is 0 what can be said about the speed of the object?

PHYS 1500 – General Physics I
Spring 2012
Instructors C and D
Mode of Assessment: Assignment (MasteringPhysics)

Measures	Problems	% Complete		% Average Score		% National Score
		Instructor C	Instructor D	Instructor C	Instructor D	
1	1.1	79.4	93.3	100	97.5	98.13
	1.2	69.1	79.6	100	87.4	83.52
	1.3	77.3	87.9	100	93.4	88.05
	1.4	74.2	79.2	100	99.2	96.01
	1.5	75.3	72.9	98.6	99.4	96.76
	1.6	73.2		98.6		92.97
2	2.1	76.3	97.5	99.5	93	91.49
	2.2	78.4	93.3	100	98.2	93.02
	2.3	69.1		97		88.60
	2.4	75.3		99.3		88.04
	2.5	76.3	87.9	100	97.9	93.04
3	3.1	73.2		98.3		95.12
	3.2	74.2	81.3	98.3	93.3	90.60
	3.3	70.1		98.5		92.70
	3.4	74.2	80.4	100	98.4	95.78
	3.5	62.9	76.3	95.5	96.0	94.61
	3.6 (Lab)			90.2	92.7	
4	4.1	59.8		94.8		85.52
	4.2	74.2	86.7	100	94.0	91.39
	4.3	70.1		95.6		86.95
	4.4	60.8		96.6		85.50
	4.5	68.0	78.8	100	96.8	92.30
	4.6	66.0	77.9	92.2	94.1	91.16
5	5.1	72.2	85.8	100	96.6	93.55
	5.2	79.4	86.7	98.7	100	97.66
	5.3	74.2	87.5	98.6	94.3	85.41
	5.4	77.3	85.4	98.7	96.1	96.81
	5.5	70.1	73.8	98.5	98.3	96.56
Average		72.1	83.8	98.1	95.8	91.5

PROBLEMS:

Measure 1: Articulate the philosophical and historical foundations of modern science.

1.1
A constant force is applied to an object, causing the object to accelerate at 6.0 m/s^2.
a) What will the acceleration be if the force is doubled?
b) What will the acceleration be if the object's mass is doubled?
c) What will the acceleration be if the force and the object's mass are both doubled?
d) What will the acceleration be if the force is doubled and the object's mass is halved?

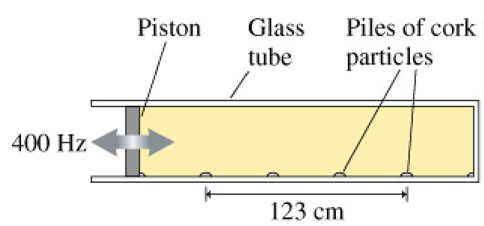
1.2
In the Bohr model of the hydrogen atom, an electron (mass m = 9.1 x 10^{-31} kg) orbits a proton at a distance of 5.3 x 10^{-11} m. The proton pulls on the electron with an electric force of 8.2 x 10^{-8} N. How many revolutions per second does the electron make?

1.3
A proton is shot at 5.0×10^7 m/s toward a gold target. The nucleus of a gold atom, with a mass 197 times that of the proton, repels the proton and deflects it straight back with 90% of its initial speed. What is the recoil speed of the gold nucleus?

1.4
A 10 cm x 10 cm x 10 cm wood block with a density of 700 kg/m^3 floats in water. What is the distance from the top of the block to the water if the water is fresh? If it's seawater?

1.5
It is said that Galileo discovered a basic principle of the pendulum - that the period is independent of the amplitude - by using his pulse to time the period of swinging lamps in the cathedral as they swayed in the breeze. Suppose that one oscillation of a swinging lamp takes 5.5 s. How long is the lamp chain?

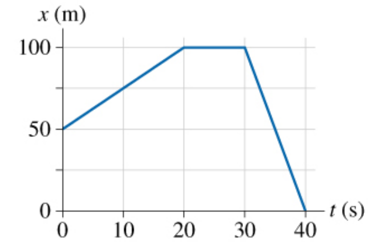
1.6
In 1866, the German scientist Adolph Kundt developed a technique for accurately measuring the speed of sound in various gases. A long glass tube, known today as a Kundt's tube, has a vibrating piston at one end and is closed at the other. Very finely ground particles of cork are sprinkled in the bottom of the tube before the piston is inserted. As the vibrating piston is slowly moved forward, there are a few positions that cause the cork particles to collect in small, regularly spaced piles along the bottom. The figure shows an experiment in which the tube is filled with pure oxygen and the piston is driven at 400 Hz.



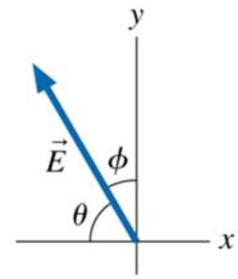
a) Do the cork particles collect at standing wave nodes or antinodes? (Hint: consider the appearance of the ends of the tube.)
b) What is the speed of sound in oxygen?

Measure 2: Understand the scientific method and demonstrate an ability to apply it across a variety of situations.

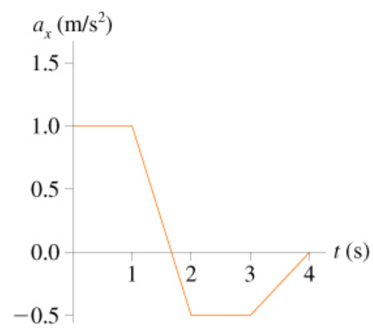
2.1
A bicyclist has the position-versus-time graph shown in the figure.
a) What is the bicyclist's velocity at t = 10 s?
b) What is the bicyclist's velocity at t = 25 s?
c) What is the bicyclist's velocity at t = 35 s?



2.2
a) What is the x-component of vector $\boldsymbol{E}$ of the figure in terms of the angle θ and the magnitude E?
b) What is the y-component of vector $\boldsymbol{E}$ of the figure in terms of the angle θ and the magnitude E?
c) For the same vector, what is the x-component in terms of the angle ϕ and the magnitude E?
d) For the same vector, what is the y-component in terms of the angle ϕ and the magnitude E?

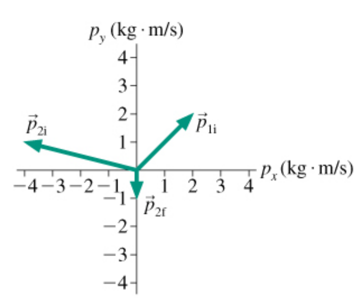


2.3
A force with x-component F_x acts on a 500 g object as it moves along the x-axis. The object's acceleration graph (a_x versus t) is shown in the figure. Draw a graph of F_x versus t.



2.4
You've always wondered about the acceleration of the elevators in the 101 story-tall Empire State Building. One day, while visiting New York, you take your bathroom scale into the elevator and stand on them. The scales read 150 lb as the door closes. The reading varies between 120 lb and 170 lb as the elevator travels 101 floors.
a) What is the magnitude of the acceleration as the elevator starts upward?
b) What is the magnitude of the acceleration as the elevator brakes to a stop?

2.5
Two particles collide and bounce apart. The figure shows the initial momenta of both and the final momentum of particle 2.
a) What is the x component of final momentum of particle 1?
b) What is the y component of final momentum of particle 1?



Measure 3: Demonstrate an ability to conduct, and interpret the results of experiments aimed at better understanding natural phenomena.

3.1

Your forehead can withstand a force of about 6.0 kN before fracturing, while your cheekbone can only withstand about 1.3 kN.

a) If a 140 g baseball strikes your head at 35 m/s and stops in 1.3×10^{-3} s, what is the magnitude of the ball's deceleration?
b) What is the magnitude of the force that stops the baseball?
c) What force does the baseball apply to your head?
d) Are you in danger of a fracture if the ball hits you in the forehead?
e) Are you in danger of a fracture if the ball hits you in the cheek?

3.2

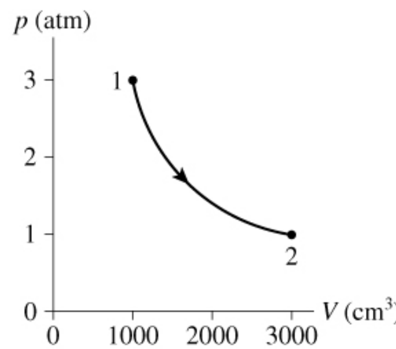
While at the county fair, you decide to ride the Ferris wheel. Having eaten too many candy apples and elephant ears, you find the motion somewhat unpleasant. To take your mind off your stomach, you wonder about the motion of the ride. You estimate the radius of the big wheel to be 15 m, and you use your watch to find that each loop around takes 25 s.

a) What is your speed?
b) What is the magnitude of your acceleration?
c) What is the ratio of your apparent weight to your true weight at the top of the ride?
d) What is the ratio of your apparent weight to your true weight at the bottom?

3.3

0.10 mol of gas undergoes the process $1\rightarrow 2$ shown in the figure.

a) What are temperatures T_1 and T_2?
b) What type of process is this?
c) The gas undergoes constant-volume heating from point 2 until the pressure is restored to the value it had at point 1. What is the final temperature of the gas?



3.4

You need to determine the density of a ceramic statue. If you suspend it from a spring scale, the scale reads 28.4 N. If you then lower the statue into a tub of water so that it is completely submerged, the scale reads 17.0 N. What is the density?

3.5

An air-track glider attached to a spring oscillates between the 14.0 cm mark and the 62.0 cm mark on the track. The glider completes 15.0 oscillations in 37.0 s. What are the (a) period, (b) frequency, (c) amplitude, and (d) maximum speed of the glider?

3.6

Lab: Archimedes' Principle:

The experiment on Archimedes' Principle conducted in the undergraduate laboratory consisted of the following tasks:

a) Determine the volume of the ring/tube using Archimedes' Principle and compare your results to the volume of the ring/tube calculated from physical measurements. Assume that the density of the water is 1.0 g/cm^3. Neatly show all work and provide all necessary data. If the TA cannot duplicate your results from the data that you provide, your score will be drastically reduced.
b) Determine the *minimum* number of pennies required to sink your block if the pennies are loaded on the block uniformly. Pennies minted after 1983 have an average mass of 2.49 grams. Assume that the density of the water is 1.0 g/cm^3. Neatly show all work and provide all necessary data. If the TA cannot duplicate your results from the data that you provide, your score will be drastically reduced.

Measure 4: Understand major issues and problems facing modern science and technology, including issues related to ethics, cultural values, public policies, and the impact of human activity upon the planet.

4.1

Seat belts and air bags save lives by reducing the forces exerted on the driver and passengers in an automobile collision. Cars are designed with a "crumple zone" in the front of the car. In the event of an impact, the passenger compartment decelerates over a distance of about 1 m as the front of the car crumples. An occupant restrained by seat belts and air bags decelerates with the car. By contrast, an unrestrained occupant keeps moving forward with no loss of speed (Newton's first law!) until hitting the dashboard or windshield. These are unyielding surfaces, and the unfortunate occupant then decelerates over a distance of only about 5 mm.

a) A 60 kg person is in a head-on collision. The car's speed at impact is 15 m/s. Estimate the net force on the person if he or she is wearing a seat belt and if the air bag deploys.
b) Estimate the net force that ultimately stops the person if he or she is not restrained by a seat belt or air bag.
c) What is the force in part (a) in terms of the person's weight?
d) What is the force in part (b) in terms of the person's weight?

4.2

Most geologists believe that the dinosaurs became extinct 65 million years ago when a large comet or asteroid struck the earth, throwing up so much dust that the sun was blocked out for a period of many months. Suppose an asteroid with a diameter of 2.0 km and a mass of 1.0×10^{13} kg hits the earth with an impact speed of 4.0×10^{4} m/s.

a) What is the earth's recoil speed after such a collision? (Use a reference frame in which the earth was initially at rest.)
b) What percentage is this of the earth's speed around the sun? (Use the astronomical data inside the cover.)

4.3

Converting sunlight to electricity with solar cells has an efficiency of 15%. It's possible to achieve a higher efficiency (though currently at higher cost) by using concentrated sunlight as the hot reservoir of a heat engine. Each dish in the figure concentrates sunlight on one side of a heat engine, producing a hot-reservoir temperature of 480ºC. The cold reservoir, ambient air, is approximately 30ºC. The actual working efficiency of this device is 30%. What is the theoretical maximum efficiency?

4.4

A typical coal-fired power plant burns 340 metric tons of coal every hour to generate 800 MW of electricity. 1 metric ton = 1000 kg. The density of coal is 1500 kg/m^3 and its heat of combustion is 28MJ/kg. Assume that all heat is transferred from the fuel to the boiler and that all the work done in spinning the turbine is transformed into electrical energy.

a) Suppose the coal is piled up in a 11 m × 10 m room. How tall must the pile be to operate the plant for one day?
b) What is the power plant's thermal efficiency?

4.5

On average, each person in the industrialized world is responsible for the emission of 10,000 kg of carbon dioxide (CO_2) every year. This includes CO_2 that you generate directly, by burning fossil fuels to operate your car or your furnace, as well as CO_2 generated on your behalf by electric generating stations and manufacturing plants. CO_2 is a greenhouse gas that contributes to global warming. If you were to store your yearly CO_2 emissions in a cube at STP, how long would each edge of the cube be?

4.6

A typical nuclear reactor generates 1000 MW of electrical energy. In doing so, it produces "waste heat" at a rate of 2000 MW and this heat must be removed from the reactor. Many reactors are sited next to large bodies of water so that they can use the water for cooling. Consider a reactor where the intake water is at 22 ºC. State regulations limit the temperature of the output water to 30 ºC so as not to harm aquatic organisms. How many kilograms of cooling water have to be pumped through the reactor each minute?

Measure 5: Demonstrate knowledge in one area of science, including understanding its basic principles, laws, and theories.

5.1

In the figure, force F_2 acts half as far from the pivot as F_1 What magnitude of F_2 causes the net torque on the rod to be zero?

5.2

Experiments using "optical tweezers" measure the elasticity of individual DNA molecules. For small enough changes in length, the elasticity has the same form as that of a spring. A DNA molecule is anchored at one end, then a force of 1.5 nN (1.5×10^{-9} N) pulls on the other end, causing the molecule to stretch by 5.0 nm (5.0×10^{-9} m). What is the spring constant of that DNA molecule?

5.3

A 20 g ball of clay traveling east at 2.0 m/s collides with a 30 g ball of clay traveling 30° south of west at 1.0 m/s.

a) What is the speed of the resulting 50 g blob of clay?
b) What is the direction of the resulting 50 g blob of clay?

5.4

A boy reaches out of a window and tosses a ball straight up with a speed of 10 m/s. The ball is 20 m above the ground as he releases it. Use energy to find:

a) The ball's maximum height above the ground.
b) The ball's speed as it passes the window on its way down.
c) The speed of impact on the ground.

5.5

A mass on a string of unknown length oscillates as a pendulum with a period of 3.5 s. Parts a to d are independent questions, each referring to the initial situation. What is the period if:

a) The mass is doubled?
b) The string length is doubled?
c) The string length is halved?
d) The amplitude is doubled?

PHYS 1510

General Physics II

PHYS 1510 – General Physics II
Fall 2011
Instructor D
Mode of Assessment: Assignment (MasteringPhysics)

Measures	Problems	% Complete	% Average Score	% National Score
1	1.1	85.4	89.5	87
	1.2	84.3	88.7	81
	1.3	77	89.1	90
2	2.1	86	85	88
	2.2	89.3	90.6	96
	2.3	77.5	87.3	89
3	3.1	83.1	91.9	93
	3.2	86	90.2	91
	3.3	93.8	98.5	95
4	4.1	89.3	97.5	95
	4.2	80.3	92.7	93
	4.3	84.3	98	95
5	5.1	87.6	92.9	94
	5.2	92.7	88.8	92
	5.3	85.4	95.3	94
Average		85.5	91.7	91.5

PROBLEMS:

Measure 1: Articulate the philosophical and historical foundations of modern science.

1.1
Light from a helium-neon laser (λ = 633 nm) is used to illuminate two narrow slits. The interference pattern is observed on a screen 3.0 m behind the slits. Thirteen bright fringes are seen, spanning a distance of 50 mm. What is the spacing (in mm) between the slits?

1.2
For a particular scientific experiment, it is important to be completely isolated from any magnetic field, including the earth's field. A 2.00m -diameter current loop with 200 turns of wire is set up so that the field at the center is exactly equal to the earth's field in magnitude but opposite in direction.(Assume that magnetic field strength at the surface of the earth is 5×10^{-5} T) What is the current in the current loop?

1.3
The earth's magnetic field, with a magnetic dipole moment of 8.4×10^{22} $A\cdot m^2$, is generated by currents within the molten iron of the earth's outer core. (The inner core is solid iron.) As a simple model, consider the outer core to be a current loop made of a 1000-km-diameter "wire" of molten iron. The loop diameter, measured between the centers of the "wires", is 3020 km. What is the current in the current loop?

Measure 2: Understand the scientific method and demonstrate an ability to apply it across a variety of situations.

2.1
A 25 pF parallel-plate capacitor with an air gap between the plates is connected to a 100*V* battery. A Teflon slab is then inserted between the plates, and completely fills the gap. What is the change in the charge on the positive plate when the Teflon is inserted?

2.2
A small electric lap blanket contains a 40-foot-long wire wrapped back and forth inside. An 18*V* supply creates a current in this wire, warming it and thus the blanket. What is the electric field strength inside this wire?

2.3
Intermittent windshield wipers use a variable resistor in an *RC* circuit to set the delay between successive passes of the wipers. A typical circuit is shown in the figure. When the switch closes, the capacitor (initially uncharged) begins to charge and the potential at point *b* begins to increase. A sensor measures the potential difference between points *a* and *b*, triggering a pass of the wipers when $V_b = V_a$. (Another part of the circuit, not shown, discharges the capacitor at this time so that the cycle can start again.)

a) What value of the variable resistor will give 12 seconds from the start of a cycle to a pass of the wipers?
b) To decrease the time, should the variable resistance be increased or decreased?

Measure 3: **Demonstrate an ability to conduct, and interpret the results of experiments aimed at better understanding natural phenomena.**

3.1
For a demonstration, a professor uses a razor blade to cut a thin slit in a piece of aluminum foil. When she shines a laser pointer (λ = 680 nm) through the slit onto a screen 5.5m away, a diffraction pattern appears. The bright band in the center of the pattern is 8.1cm wide. What is the width of the slit?

3.2
An uncharged capacitor is connected to the terminals of a 2.0V battery, and 12μC flows to the positive plate. The 2.0V battery is then disconnected and replaced with a 8.0V battery, with the positive and negative terminals connected in the same manner as before. How much additional charge flows to the positive plate?

3.3
The current in an electric hair dryer is 14 A .
a) How much charge flow through the hair dryer in 3.0 min ?
b) How many electrons flow through the hair dryer in 3.0 min ?

Measure 4: **Understand major issues and problems facing modern science and technology, including issues related to ethics, cultural values, public policies, and the impact of human activity upon the planet**.

4.1
The total charge a household battery can supply is given in units of mA·hr. For example, a 9.0 V alkaline battery is rated 450 mA·hr, meaning that such a battery could supply a 1 mA current for 450 hr, a 2 mA current for 225 hr, etc. How much energy, in joules, is this battery capable of supplying?

4.2
Two particles orbit the earth's magnetic field lines. What is the frequency of the circular orbit for (a) an electron with speed 1.0×10^6 m/s? (b) A proton with speed 5×10^4 m/s?

4.3
Your eyes have three different types of cones with maximum absorption at 437 nm, 533 nm, and 564 nm. What photon energies correspond to these wavelengths?

Measure 5: **Demonstrate knowledge in one area of science, including understanding its basic principles, laws, and theories**.

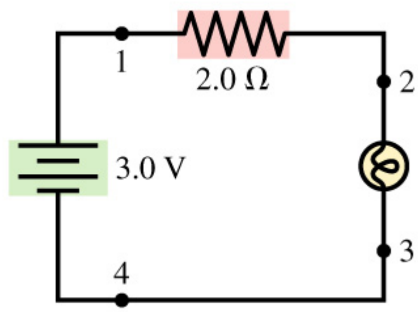
5.1
How long does it take light to travel through a 2.8mm-thick piece of window glass? Through what thickness of water could light travel in the same amount of time?

5.2
Two 4.0kg masses are 1.0m apart on a frictionless table. Each has 1.0μC of charge.
a) What is the magnitude of the electric force on one of the masses?
b) What is the initial acceleration of each mass if they are released and allowed to move?

5.3

The light-bulb in the circuit diagram of the figure has a resistance of 1.4Ω. Let ΔV_{ab} represent the magnitude of the potential difference between points a and b.

a) What is the value of ΔV_{12}?
b) What is the value of ΔV_{23}?
c) What is the value of ΔV_{34}?
d) What is the value of ΔV_{12} if the bulb is removed?
e) What is the value of ΔV_{23} if the bulb is removed?
f) What is the value of ΔV_{34} if the bulb is removed?



PHYS 1510 – General Physics II
Spring 2012
Instructors E, F, and G
Mode of Assessment: Assignment (MasteringPhysics)

Measures	Problems	% Complete			% Average Score			% National Score
		Instructor E	Instructor F	Instructor G	Instructor E	Instructor F	Instructor G	
1	1.1	98.7	86.1		94.9	97.7		95.43
	1.2	93.7		85.5	100.0		83.7	95.65
	1.3	74.7	80.2		84.7	98.8		95.90
	1.4	79.7	78.2	84.8	84.1	97.5	84.8	83.04
	1.5	84.8	84.2	84.1	97.0	97.6	84.1	97.30
2	2.1	94.9	81.2		84.0	97.6		90.00
	2.2	91.1	82.2	91.0	100.0	99.6	92.3	98.22
	2.3	77.2		80.7	85.2		85.6	86.21
	2.4	87.3	83.2		100.0	99.6		97.37
	2.5	88.6	84.2	86.2	97.1	98.8	93.4	96.55
3	3.1	94.9	83.2		93.3	98.8		95.50
	3.2	78.5	85.1	86.9	90.3	98.8	91.4	95.77
	3.3	77.2	79.2	82.1	98.4	92.5	74.0	87.34
	3.4	75.9	86.1	89.0	98.3	99.4	97.0	97.06
	3.5	72.2	84.2	86.9	98.2	98.8	94.0	95.19
	3.6 (Lab)				90.0	96.4	96.8	
4	4.1	83.5	73.3		92.4	93.2		90.01
	4.2	78.5	87.1	89.0	96.8	96.6	87.8	94.64
	4.3	83.5	84.2	84.1	97.0	96.5	87.4	92.37
	4.4	72.2	81.2	89.7	96.0	95.1	94.8	94.11
	4.5	59.5	76.2	83.4	91.5	97.4	98.9	92.77
5	5.1	81.0	81.2	86.9	98.4	98.4	81.6	96.08
	5.2	83.5	70.3	77.9	92.4	96.7	95.9	90.26
	5.3	78.5	84.2	89.0	79.0	96.5	93.0	90.50
	5.4		82.2			98.8		100.0
	5.5	83.5	82.2	82.8	96.0	100	96.5	97.03
Average		82.2	81.7	85.6	93.4	97.5	90.2	93.8

PROBLEMS:

Measure 1: Articulate the philosophical and historical foundations of modern science.

1.1
Light from a sodium lamp (λ = 589 nm) illuminates two narrow slits. The fringe spacing on a screen 150 cm behind the slits is 4.0 mm. What is the spacing (in mm) between the two slits?

1.2
A plastic rod that has been charged to -15.0 nC touches a metal sphere. Afterward, the rod's charge is -10.0 nC.
a) What kind of charged particle was transferred between the rod and the sphere?
b) In which direction was the charged particle transferred between rod and sphere? That is, did it move from the rod to the sphere or from the sphere to the rod?
c) How many charged particles were transferred?

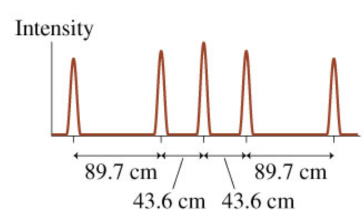
1.3
In a semiclassical model of the hydrogen atom, the electron orbits the proton at a distance of 0.053 nm.
a) What is the electric potential of the proton at the position of the electron?
b) What is the electron's potential energy?

1.4
An electron confined in a one-dimensional box is observed, at different times, to have energies of 12 eV, 27 eV, and 48 eV. What is the minimal length of the box?

1.5
The wavelengths in the hydrogen spectrum with m = 1 form a series of spectral lines called the Lyman series.
a) Calculate the wavelength of the first member of the Lyman series.
b) Calculate the wavelength of the second member of the Lyman series.
c) Calculate the wavelength of the third member of the Lyman series.
d) Calculate the wavelength of the fourth member of the Lyman series.

Measure 2: Understand the scientific method and demonstrate an ability to apply it across a variety of situations.

2.1
The figure shows the interference pattern on a screen 0.95 m behind an 820 line/mm diffraction grating. What is the wavelength of the light?

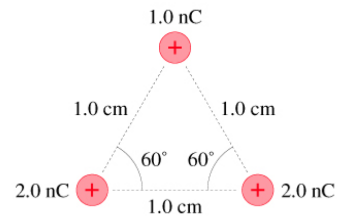


2.2
An object is 30 cm in front of a converging lens with a focal length of 10 cm.
a) Use ray tracing to determine the location of the image.
b) Is the image upright or inverted?
c) Is the image real or virtual?

2.3

a) What is the force on the 1.0 nC charge in the figure? Give the magnitude.

b) Give the direcion.

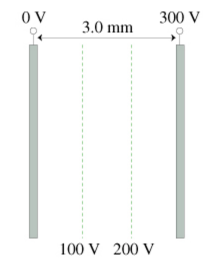


2.4

a) In the figure, which capacitor plate, left or right, is the positive plate?

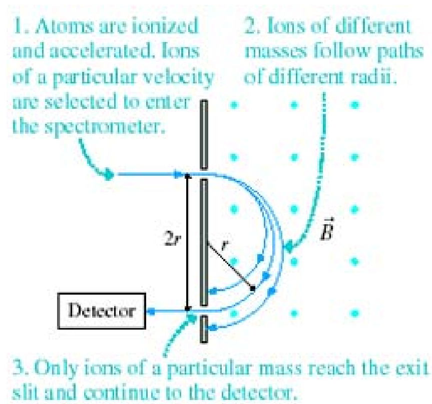
b) What is the electric field strength inside the capacitor?

c) What is the potential energy of a proton at the midpoint of the capacitor?



2.5

A mass spectrometer is designed to separate protein fragments. The fragments are ionized by removing a single electron and then enter a 0.80 T uniform magnetic field at a speed of 2.3×10^5 m/s. If a fragment has a mass that is 85 times the mass of the proton, what will be the distance between the points where the ion enters and exits the magnetic field?



Measure 3: Demonstrate an ability to conduct, and interpret the results of experiments aimed at better understanding natural phenomena.

3.1

The wings of some beetles have closely spaced parallel lines of melanin, causing the wing to act as a reflection grating. Suppose sunlight shines straight onto a beetle wing. If the melanin lines on the wing are spaced 2.0 μm apart, what is the first-order diffraction angle for green light (λ = 550 nm)?

3.2

The aurora is caused when electrons and protons, moving in the earth's magnetic field of $\approx 5 \times 10^{-5}$ T, collide with molecules of the atmosphere and cause them to glow. What is the radius of the circular orbit for:

a) an electron with speed 4.0×10^6 m/s

b) a proton with speed 5.0×10^4 m/s

3.3

Bats are capable of navigating using the earth's field-a plus for an animal that may fly great distances from its roost at night. If, while sleeping during the day, bats are exposed to a field of a similar magnitude but different direction than the earth's field, they are more likely to lose their way during their next lengthy night flight. Suppose you are a researcher doing such an experiment in a location where the earth's field is 50 μT at a 60º angle below horizontal. You make a 50 cm diameter, 100-turn coil around a roosting box; the sleeping bats are at the center of the coil. You wish to pass a current through the coil to produce a field that, when combined with the earth's field, creates a net field with the same strength and dip angle (60º below horizontal) as the earth's field but with a horizontal component that points south rather than north.

a) What is the proper orientation of the coil?
b) What is the necessary current?

3.4

Patients undergoing an MRI occasionally report seeing flashes of light. Some practitioners assume that this results from electric stimulation of the eye by the emf induced by the rapidly changing fields of an MRI solenoid. We can do a quick calculation to see if this is a reasonable assumption. The human eyeball has a diameter of approximately 25 mm. Rapid changes in current in an MRI solenoid can produce rapid changes in field, with $\Delta B/\Delta t$ as large as 50 T/s.

a) What emf would this induce in a loop circling the eyeball?
b) How does this compare to the 15 mV necessary to trigger an action potential?

3.5

A firefly glows by the direct conversion of chemical energy to light. The light emitted by a firefly has peak intensity at a wavelength of 550 nm.

a) What is the minimum chemical energy, in eV, required to generate each photon?
b) One molecule of ATP provides 0.30 eV of energy when it is metabolized in a cell. What is the minimum number of ATP molecules that must be consumed in the reactions that lead to the emission of one photon of 550 nm light?

3.6

<u>Lab: Series & Parallel Resistors</u>

The experiments on Series and Parallel DC circuits conducted in the undergraduate laboratory consisted of the following tasks given below. Students explored how voltages across resistors and currents going through resistors behaved under various combinations of resistors in series and parallel. The students also built circuits and verified the voltages, currents, and resistances using a multimeter.

Part I: Series & Parallel Combinations with Two and Three Resistors (40 pts total)

Calculate the total resistance of each circuit, the voltage across each resistor and the current going through each resistor for the given circuits. After you have theoretically determined the resistances, voltages and currents, assemble each circuit using the two 100Ω resistors and the 200Ω resistor your group has been provided, and verify the voltages and currents using a multimeter.

Part II: Series and Parallel Combinations using Four Resistors (60 pts total)

Your group will use the schematic below (also located on the Data Sheet) to design a circuit that will meet the three (3) criteria your group has been assigned. Your TA will assign your group one of the 12 sets of conditions. Your group must use two 100Ω resistors, one 200Ω resistor, and a 50Ω resistor, and only these values, to build your circuit by assigning them to the correct positions in the circuit. When you are confident that your group has designed your circuit properly and your group has calculated the current that will pass through the 50Ω resistor, your TA will come to your station and provide your group with a 50Ω resistor and test your group’s knowledge of the circuit.

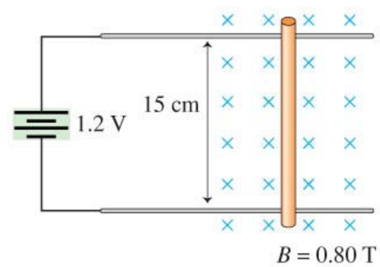
Measure 4: Understand major issues and problems facing modern science and technology, including issues related to ethics, cultural values, public policies, and the impact of human activity upon the planet.

4.1
In proton-beam therapy, a high-energy beam of protons is fired at a tumor. The protons come to rest in the tumor, depositing their kinetic energy and breaking apart the tumor's DNA, thus killing its cells. For one patient, it is desired that 0.10 J of proton energy be deposited in a tumor. To create the proton beam, the protons are accelerated from rest through a 10 MV potential difference. What is the total charge of the protons that must be fired at the tumor to deposit the required energy?

4.2
Although the evidence is weak, there has been concern in recent years over possible health effects from the magnetic fields generated by transmission lines. A typical high-voltage transmission line is 20 m off the ground and carries a current of 200 A.

a) Estimate the magnetic field strength on the ground underneath such a line.
b) What percentage of the earth's magnetic field does this represent?(Assume that magnetic field strength at the surface of the earth is 5×10^{-5} T)

4.3
A device called a railgun uses the magnetic force on currents to launch projectiles at very high speeds. An idealized model of a railgun is illustrated in the figure. A 1.2V power supply is connected to two conducting rails. A segment of copper wire, in a region of uniform magnetic field, slides freely on the rails. The wire has a 0.85 mΩ resistance and a mass of 5.5 g. Ignore the resistance of the rails.



a) When the power supply is switched on, what is the current?
b) What is direction of the force on the wire?
c) What is the magnitude of the force on the wire?
d) What will be the wire's speed after it has slid a distance of 7.3 cm?

4.4
One recent study has shown that x rays with a wavelength of 0.0050 nm can produce significant numbers of mutations in human cells.

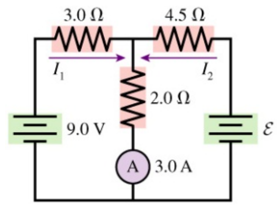
a) Calculate the energy in eV of a photon of radiation with this wavelength.
b) Assuming that the bond energy holding together a water molecule is typical, use table 25.1 in the textbook to estimate how many molecular bonds could be broken with this energy.

4.5
The Chernobyl reactor accident in what is now Ukraine was the worst nuclear disaster of all time. Fission products from the reactor core spread over a wide area. The primary radiation exposure to people in western Europe was due to the short-lived (half-life 8.0 days) isotope ^{131}I, which fell across the landscape and was ingested by grazing cows that concentrated the isotope in their milk. Farmers couldn't sell the contaminated milk, so many opted to use the milk to make cheese, aging it until the radioactivity decayed to acceptable levels. How much time must elapse for the activity of a block of cheese containing ^{131}I to drop to 1.0% of its initial value?

Measure 5: Demonstrate knowledge in one area of science, including understanding its basic principles, laws, and theories.

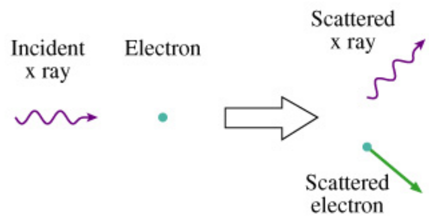
5.1
A proton with an initial speed of 800000 m/s is brought to rest by an electric field.
a) Did the proton move into a region of higher potential or lower potential?
b) What was the potential difference that stopped the proton?
c) What was the initial kinetic energy of the proton, in electron volts?

5.2
The ammeter in the figure reads 3.0 A. (a) Find I_1. (b) Find I_2. (c) Find ε.



5.3
A 1300-turn coil of wire that is 2.1 cm in diameter is in a magnetic field that drops from 0.13 T to 0 T in 9.0 ms The axis of the coil is parallel to the field. What is the emf of the coil?

5.4
Further support for the photon model of electromagnetic waves comes from Compton scattering, in which x-rays scatter from electrons, changing direction and frequency in the process. Classical electromagnetic wave theory cannot explain the change in frequency of the x-rays on scattering, but the photon model can. Suppose an x-ray photon is moving to the right. It has a collision with a slow-moving electron, as in the figure. The photon transfers energy and momentum to the electron, which recoils at a high speed. The x-ray photon loses energy, and the photon energy formula $E = hf$ tells us that its frequency must decrease. The collision looks very much like the collision between two particles.



a) What happens when the x-ray photon scatters from the electron?
b) What happens when the x-ray photon scatters from the electron?
c) What happens when the electron is struck by the x-ray photon?
d) X-ray diffraction can also change the direction of a beam of x-rays. Which statement offers the best comparison between Compton scattering and x-ray diffraction?

5.5
The figure is an energy-level diagram for a simple atom:
a) What wavelengths appear in the atom's emission spectrum?
b) What wavelengths appear in the atom's absorption spectrum?