CCBC
Fall 2021
SoMS – Physical Science
General Physics - PHYS 251

CK1- 92257

Contents

PHYS 101 - 4 Credits - **General Physics II** introduces electricity and magnetism, kinetic theory, thermodynamics, thermal energy, and heat. It builds on PHYS 151 as the second course in a three-semester set of calculus-based courses in the basic principles of physics for students majoring in Engineering, Mathematics, or a physical science.

4 credits: 3 lecture hours, 1 recitation hour, and 3 laboratory hours *per* week. This lab course may be used to fulfill 4 credits of the General Education requirement in Biological and Physical Sciences.

Prerequisites: A grade of C or better in both PHYS 151 and MATH 251.

A. Basic Course Information

1. Instructor: Dr Dave Baum
2. Contact information: Catonsville MASH 016 - (443) 840 – 4341 - DBAUM@CCBCMD.EDU (preferred means) – Course Webpage: http://cwoer.ccbcmd.edu/science/physics/Baum/PHYS251F21/PHYS251F21.htm
3. Office Hours: after class MWF 11:30 – 12:00 TR 1:00 – 2:00.
4. Contact Turn-around Time: I expect to get back to your eMail inquiries within two work days. Phone messages may take up to a week. I do not respond to messages in Brightspace.
5. Catonsville Physical Science Dept: 443-840-4560.
6. Class Times, Days, and Locations: COMBINED LECTURE/LAB TR 9:00 – 12:15 in C-MASH 038.
7. This is a four credit hour course. For each credit hour, the student is expected to complete at least two hours of work per week outside of the class, including doing homework and practice problem solving, reading, writing laboratory reports, and preparing for exams.

Note that these are minimal requirements for any course and that many students require more time than this for science courses.

8. Required Materials:
    a) For laboratory courses, appropriate clothing (including shoes that cover the tops of the feet and have good traction) is required. See "Course Procedures" for more information. In addition, you must come with a mask; additional required PPE will be provided by the College.
    b) Ling, Sanny, and Moebs, University Physics Vol 2, Openstax. The bookstore will sell you a hardbound copy, or you can download a free copy from: https://openstax.org/details/books/university-physics-volume-2. You wil also need Volume 1: https://openstax.org/details/books/university-physics-volume-1.
    c) The Laboratory Manual is available at the Bookstore.
    d) A cheap scientific calculator that can do trig functions, scientific notation, and natural exponents/logs (about $10). An $80 programmable graphing calculator is not necessary. Cell phone calculators are not allowed during exams.

    Optional Materials:
    e) The textbook study materials, available at https://openstax.org/details/books/university-physics-volume-2?Student resources.
    f) A pair of safety glasses may be needed for some labs. Some common-use goggles will be made available.
    g) It is also recommended that you purchase a regular lined composition book in which to write practice problems.
9. Additional basic information
    a) You may be asked to complete a number of surveys during the semester in addition to the usual course evaluations.
    b) The College requires you to check your College eMail for important messages. Federal regulations require that we must fully determine the identity of the emailing party, and further require that we disclose student information to only the student. In order to meet these requirements for email communication, only emails received from the student's CCBC email account will get a response. Be sure to send ALL email with your CCBC email account to avoid delays in communicating with your instructor.

B. Course Goals Overall

1. Course objectives: Upon completion of this course, the student will be able to:

a) apply Coulomb's law of electrostatic force;
b) solve problems of force and motion in electric fields;
c) develop models of electric potential from energy and electrostatic force concepts;
d) demonstrate that there are often several ways to model processes and behavior, explain the limitations of those models, and discuss the ethics of using and misusing models;

e) analyze elementary Direct Current (DC) circuits with Ohm's relationship and Kirchhoff's rules;
f) apply the Lorentz magnetic force laws;
g) solve induction problems with Faraday's law and Lenz's law;
h) analyze series Resistor-Inductor-Capacitor Alternating Current (RLC AC) circuits using Kirchhoff's rules;
i) solve problems related to energy and entropy;
j) derive relationships for the kinetic theory of gases;
k) perform a collaborative laboratory investigation;
l) use computer-based data collection methods;
m) plot and analyze data using Excel;
n) evaluate the results of experiments in terms of supporting or disproving theoretical concepts;
o) find, evaluate, use, and locate appropriate resources such as the accepted values of measured quantities or useful physical relationships not discussed in class by using appropriate technology or other more traditional reference sources;
p) write coherent laboratory reports that follow the required format;
q) properly acknowledge reference sources and others' contributions to collaborative work;
r) explain the expectations of professional behavior within the scientific community and the ramifications of misconduct, and
s) discuss the universal applicability of the laws of physics, making them the intellectual property of all cultures and segments of humankind.

2. Major topics:

a) Electric Charge and Electric Field
   i. Coulomb's law
   ii. Electric field
b) Gauss's Law
c) Electric Potential
d) Capacitance and Dielectrics
   i. Capacitance
   ii. Series and parallel combinations of resistors
e) Current, Resistance, and Electromotive Force
   i. Current
   ii. Resistance
   iii. Ohm's relationship
   iv. Batteries
   v. Series and parallel combinations of resistors
   vi. Power
f) Direct-Current Circuits
   i. Resistor network reduction

ii. Kirchhoff's rules
iii. Resistor-capacitor (RC) circuits
iv. Inductor-resistor (LR) circuits

g) Magnetic Field and Magnetic Forces
i. Magnets and the earth's magnetic field
ii. Lorentz force
iii. Magnetic fields of simple configuration currents
iv. Ampère's law
v. Magnetic effects and domains

h) Electromagnetic Induction and AC Circuits
i. Faraday's law
ii. Self-inductance
iii. LR circuits
iv. Mutual inductance and transformers
v. AC LRC circuits and resonance

i) Temperature and Heat
i. Zeroth law of thermodynamics
ii. Thermal expansion
iii. Mechanisms of heat transfer

j) Thermal Properties of Matter
i. Ideal gases
ii. Heat capacities and calorimetry
iii. Latent heat and phase changes

k) First Law of Thermodynamics
i. Work
ii. Internal energy

l) Second Law of Thermodynamics
i. Heat engines
ii. Carnot cycle
iii. Entropy

m) Global Developments in Physics

n) Universal Application of Physics Principles

3. Rationale

This course is part of a three semester sequence. Although it will provide you with some specific knowledge and skills that will be useful to you in your future studies, it is also a vehicle to help you acquire the ability to construct arguments using a logical progression of steps from premise to conclusion and an exercise in clear and concise expression. In addition, this course demonstrates that there are often several ways to model processes and behavior and provides practice in constructing models and realizing the limitation of

those models. It is an opportunity to develop the ability to extrapolate and apply current knowledge to new situations.

C. Evaluation

Requirements[1]: (papers, oral reports, projects, quizes, tests, final exams, *et c.*):

a) The four highest scores of the five exams constitute 64% of your final grade; that is to say that your lowest exam grade will be ignored. There will be NO make-up exams; a missed exam will be given a grade of zero, which will then be dropped as your lowest grade. Situations involving two, excusable, missed exams shall be treated on an individual basis. Your fifth regular exam will occur on final day. Exams may cover any material presented in class or in the textbook, unless a section is specifically omitted. A relationship sheet will be provided for your use. Questions on the grading of an exam must be brought to my attention within a week of the exam's return. You may be asked to present a photo ID at each exam. Seating during exams may be assigned.

b) Homework assignments, in-class quizes, and special projects will total 11%. Expect that an assignment will be due at the beginning of every class day; if the assignment is not announced at the end of class, check your e-mail later in the day. Not all assigned problems will be graded. No late homework will be accepted, but some number of homework grades will be dropped in the same manner as for exams. Answers to all assigned problems will be made available for your inspection.

c) Laboratory work counts 25%. A maximum of two missed laboratories can be made up *per* the procedures listed in the lab manual. There will be at least 11 lab exercises.

d) There is no extra credit.

1. Grading policy:

Final grades will be calculated as follows:
≥ 90% A
≥ 80% B
≥ 60% C
≥ 50% D
< 50% F

Please note that this system eliminates competition among students, so there is no reason not to help one another. Each student should keep a record of his grades. Students may request an estimated grade at any time.

Also, *please note that a D is a passing grade*; although some programs and courses may require a higher grade, a D will earn you credits toward graduation.

2. Attendance policy:

   Attendance is not mandatory, but non-attendance will almost certainly affect how well you perform on assignments. Remember that no late homework assignments or missed exams will be made up, although, some number of homework assignments and your lowest exam grade will be dropped at the end of the semester, and two missed laboratory exercises may be made up near the end of the semester at a common time to be announced. The exception is if you decide to AUDIT the class, in which case attendance becomes mandatory.

3. Audit policy:

   You can no longer wait until mid-semester to decide that auditing a course is appropriate; the final date to change to an audit now coincides with the final date for withdrawing with a 50% refund. Failure to participate in the class as an audit will result in a grade of W instead of AU. The last day to change to an 'audit' this semester is: September 17th, 2021.

D. Course Procedures

1. Course-related policies and procedures:

   a) Attendance is not mandatory, but no late homework assignments or missed exams will be made up. *Exception: any student registered as an audit must attend regularly; failure to do so will result in a grade change to either W or whichever letter grade is appropriate for the completed work.*
   b) You will be given a relationship sheet for each exam; a copy is available through the link on the course webpage. You may also find it helpful when doing your homework assignments. Please feel free to ask for additional relationships *during* the exams if you think you need them to complete a problem.
   c) I have not made a detailed list of material to be covered in class, but it is my intention to cover at least Chapter 14 in Volume 1 and Chapters 1-16 in Volume.
   d) Cheating policy: You are permitted, indeed, encouraged, to consult with classmates on labwork and homework. However, presenting another's work as your own is considered cheating. You should therefore always present material from a reference source in your own words and credit that source. Collaboration on exams is not allowed; no cell phone calculators are allowed during exams. Any cases of academic dishonesty will be dealt with according to College policies (see Office of Judicial Affairs: http://www.ccbcmd.edu/judicialaffairs/index.html).

e) In accordance with the Americans with Disabilities Act, CCBC is committed to providing equal access to educational opportunities for all students by arranging support services and reasonable accommodations for students with disabilities. A student with a disability may contact the appropriate campus office for an appointment to discuss reasonable accommodations. An appointment must be scheduled within a time period that allows staff adequate time to respond to the special needs of the student. The student must provide the appropriate office with proper documentation supporting the need for reasonable accommodations. Contact Beth Hunsinger in the Office of Disability Support Services at 443-840-1741. Once you are approved, notify me as soon as possible.

f) There will be no cell phone activity during class. If you are expecting an important call, be sure your phone is on vibrate and take the call in the hall. There will be no cell phone activity at all during exams.

g) A student may not leave the classroom during an exam for any reason. Leaving the classroom means that the exam has been submitted and the student will not be allowed to continue working on the exam upon return. Students should make sure to have all items needed to take the exam and take care of any personal business prior to the start of class on exam days. If there is a medical reason why a student cannot sit for two hours, the student should contact the Office of Disability Support with proper documentation to obtain an accommodation letter. Accommodations are not retroactive.

h) No food or drink is allowed in class. Closed-toed shoes are required to provide protection from broken glass, heavy objects, and other hazards. On occasion, safety glasses will be required during laboratory exercises. Failure to abide by this policy shall result in your removal from the classroom.

i) This class cannot be recorded without my written permission. A request form is available.

j) Anyone who is not officially registered for this class may not attend.

2. For college-wide syllabus policies, such as the Code of Conduct for Academic Integrity, Grades and Grading (including FX and progress grades), and the Audit/Withdrawal policies, please go to the MySyllabiPolicies tab on the myCCBC page.

3. To access information about student services, such as Academic Advising, College and Community Outreach/Success Navigators, and Disability Support Services, students may refer to the Student Support Services link on the CCBC catalog home page.

4. Contact information for course-related concerns: Students should first attempt to take concerns to the faculty member. If you are unable to resolve course-related concerns with the instructor, you should contact Dr Erica L. DiCara, Catonsville Physical Science Coördinator, at edicara@ccbcmd.edu, or at 443-840 4119.

5. Course calendar/schedule

   August 29th – Drop with 100% Refund Deadline
   August 30th – Classes Start
   September 15th –December Graduation Application deadline
   September 16th – EXAM I
   September 17th –50% Refund Deadline – Audit Deadline
   October 7th – EXAM II
   October 28th – EXAM III
   November 5th –Withdrawal Deadline
   November 18th – EXAM IIII
   November 24th – 28th – Thanksgiving Holiday
   December 9th – Last Day of Classes
   December 14th – Optional Q Session (11-1)
   December 16th – EXAM V (9-11)
   March 4th - Incomplete Makeup Deadline

6. Material in Brightspace will be available until February 1st.

This syllabus may be changed with notification to the class.

List of Full URLs used in this document:

CCBC Catalog: http://catalog.ccbcmd.edu/index.php

myCCBC page: https://myccbc.ccbcmd.edu/

Office of Judicial Affairs: http://www.ccbcmd.edu/judicialaffairs/index.html

Course Webpage: http://cwoer.ccbcmd.edu/science/physics/Baum/PHYS251F21/PHYS251F21.htm

Textbook: https://openstax.org/details/books/college-physics

Ancilliary materials: https://openstax.org/details/books/college-physics?Student resources

Turning in Homeworks and Lab Reports to BrightSpace

(PHYS251)

Deadlines

You should expect a HW assignment to be due at the beginning of almost every class. Brightspace has an automatic cutoff set for 9:00 a.m. for HWs. No late HW is accepted. Laboratory reports are due one week after the experiment is performed, but I will pad in a couple extra days for those. If you wish to submit a lab report after the BrightSpace cutoff, see me.

Submission Guidelines

Assignments shall be submitted through the slots in BrightSpace as a single document in PDF format. Lab reports should be typed and any graphs inserted into the body of the report, and the report printed as a PDF.

HWs will, I assume, be written by hand, so each page should be scanned, converted to a PDF, and the PDFs combined into a single file for submission. There are a number of free applications with which to do this. Your pages should look like the figure on the top left, and not like the others. Be sure to put your name on the assignment.[1]

Return of Assignments

Assignments will be returned through BrightSpace as well. However, the grade you see associated with the assignment there is NOT your grade; you will probably just see a '1.'. You must download the returned assignment to see the grade and comments.

[1] Here are some suggestions:

The **Microsoft OneDrive app** will let you snap a series of photos and will then automatically convert them into a single PDF document saved in your OneDrive Account. This is what we recommend using.

Adobe Scan works quite well.

If all else fails, insert your photos (jpgs or gifs or whatever), one to a page, into a Word document and choose **Microsoft Print to PDF** as your printer.

$S(x) = 14 \sin x \cos x$ $n=4$

$$\frac{14}{\pi}\int_0^{\pi} \sin x \cos x \cos 4x \, dx$$

$$\frac{14}{\pi}\int_0^{\pi} \sin x \cos x \sin 4x \, dx$$

$\cos 2x = 2\cos^2\theta - 1$

$\sin 2x = 2\sin\theta\cos\theta$

$\cos 3x = 4\cos^3 - 3\cos\theta$

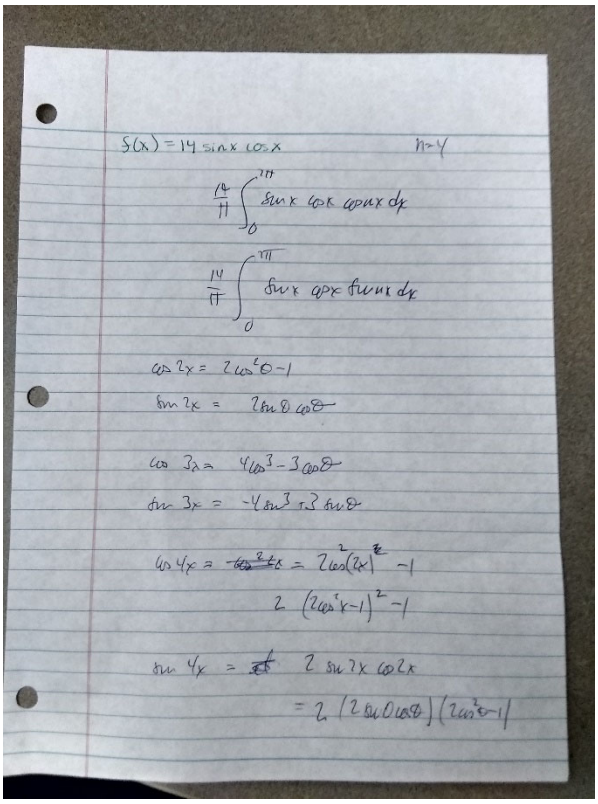
$\sin 3x = -4\sin^3 + 3\sin\theta$

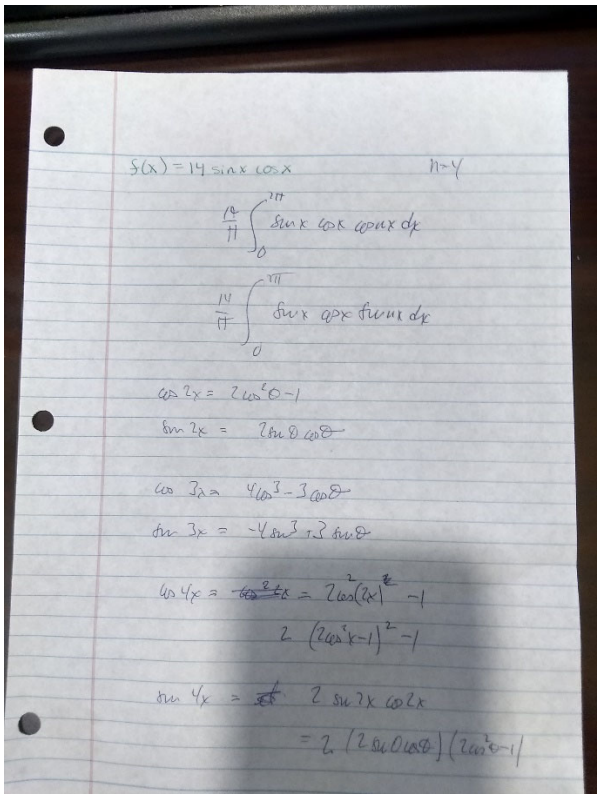
$\cos 4x = \cancel{\cos^2 2x} = 2\cos^2(2x)^2 - 1$

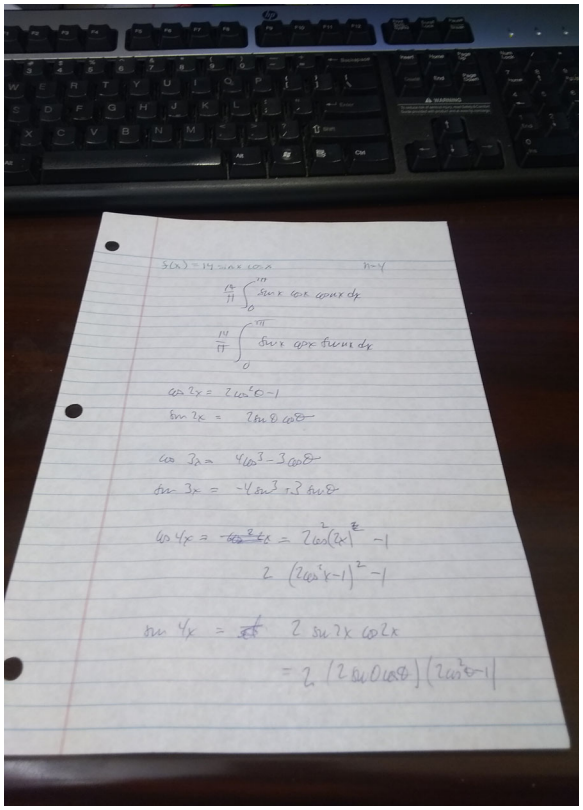
$2(2\cos^2 x - 1)^2 - 1$

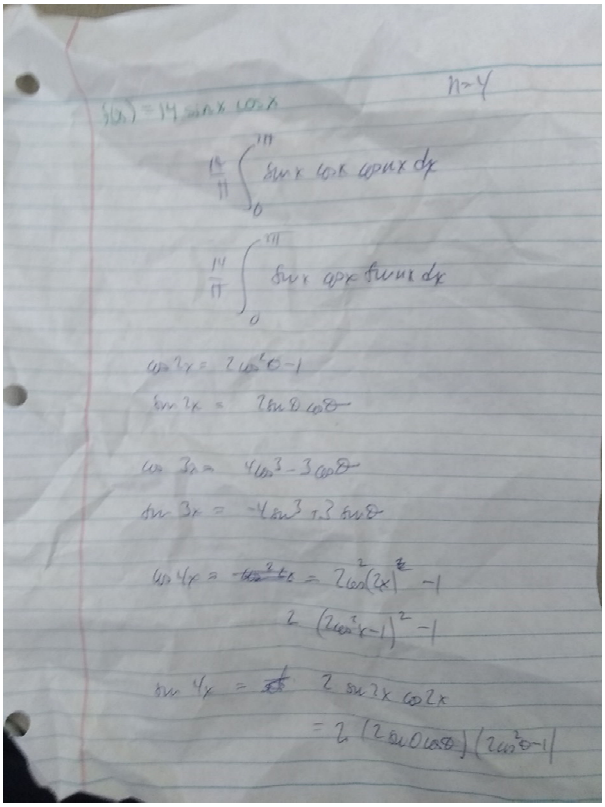
$\sin 4x = \cancel{2\sin} \; 2\sin 2x \cos 2x$

$= 2[2\sin\theta\cos\theta][2\cos^2\theta - 1]$









Laboratory Exercises

About the Laboratory Component -

The scheduled laboratory periods may be used for lab exercises, as question sessions before the exams, or if necessary as additional lecture time. A student who misses a lab will be given an opportunity to perform a substitute exercise during the semester at a time arranged with the consent of the instructor. The average of the lab grades will count as 25% of the student's final course grade, unless the course instructor indicates otherwise. Lab partners will be assigned and rotated several times during the semester. If your instructor uses a sign-in sheet or attendance sheet, be certain that your name is included.

The student will keep a notebook (e.g. Ampad #26-251) of all laboratory work. Notebooks will be written neatly and clearly, and in ink. Equipment lists, any deviation from the written procedures, data, results, and conclusions will be written in the notebook (see below for guidelines). The notebook will then form the outline for any formal reports required. No loose sheets may be used as scrap. Any errors or changes must be struck out with a single, light stroke with the corrected value written nearby. No pages are to be removed, and the information is not to be recopied later into a 'cleaner, neater' notebook. Graphs should be glued or stapled into the book, one graph per page. The instructor will examine and sign each notebook before it leaves the laboratory classroom; it is the student's responsibility to ensure that this is done. Never disassemble your apparatus until your notebook has been checked; your instructor may require you to take new or additional data, and be able to check for problems with the apparatus. A notebook must be capable of reminding the author of the procedures and results in case his or her work is questioned and the experiment must be repeated. A good self-test if enough information has been included is to ask whether a student at some other school could duplicate the experiment using just the notebook and lab manual.

Construct a table similar to the one below on the first page of your notebook.

Lab #	Date	Title	Instructor's Signature
01			
02			
03			

The grade for the lab portion of the course will be based on formal reports AND the notebook checks. If a laboratory exercise is performed, but no report is submitted by the due date, present the signed notebook as your proof that you did the lab and half credit may be awarded. Notebooks and formal reports will follow the general format given below, although some sections may be combined if it seems better to do so. Laboratory reports are due one week after the exercise is performed. Slightly late reports may be accepted at the instructor's discretion, provided this allowance is made equally for all students. Once the reports are returned, you have one week to bring any questions or complaints to the instructor's attention; after that, the grades are finalized.

Below is a general idea of the structure of a physics lab report. Make sure to follow additional procedures and rubrics provided by your instructor.

- Student Name - Title - Date - Names of Partners
- Objective of Experiment - The objective is often to verify some relationship which was presented in class. You may paraphrase the objective as stated in the lab manual.
- Description of Experimental Apparatus – Provide a list of the apparatus used.
- Procedure(s) – If the procedure corresponds exactly with that given in the lab manual, then write 'The procedure in the manual was followed exactly.' Any deviations from the given procedure should be included in the report.
- Data (if appropriate) - Data should be presented in the form of a graph, when appropriate. Data should be presenting in table form only if no graph was required in the exercise.
- Results –This section should present the final results and include a discussion of how the results were obtained from the data.
- Conclusions – Lab exercises often call for comparison of the student's answer to some accepted value or confirming a particular relationship among variables. Did the experiment support whatever hypothesis was discussed? What mathematical relationship connects two or more variables? What are the implications of these results? Were there any problems with the experiment that could be corrected?

Professor Clark has make a video that explains this process in more detail:

https://www.youtube.com/watch?v=j01DZZuOwCE&feature=youtu.be

The reports must be typed, although figures may be hand-sketched. Graphs must be created using Excel or a similar program. Formal reports do not need to be overly long; just include what's necessary. Reports will be written in third-person passive voice (*e.g.*, not 'We dropped the ball from a height of two meters,' but rather 'The ball was dropped from a height of two meters.'). The language should be clear, concise, and natural. Do not blame poor results on 'human error' unless there is a reaction time effect or something similar; poor experimental technique should not be explained away, it should be corrected before you leave. Now, on occasion, it may be that an apparatus will not yield good results because the equipment is worn or broken. We can only assure the student that the instructor has performed each experiment and obtained reasonable results, and that the equipment was all present and in working order before the student arrived. Notebooks will not be signed until all apparatus have been stored properly.

In addition, note that there will be no food or drink allowed in the lab room, electronic devices will be off and put away, and that appropriate dress is required (covered shoes required, no sandals; occasionally, long pants are required). Lab groups may be assigned and will comprise no more than four students. Attendance at and participation in laboratory exercises is mandatory; students more than a few minutes late to lab may be asked to leave and perform a make-up instead. Students are responsible for returning the lab equipment to its original state. Students must be certain to have the instructor sign notebooks before leaving. Violations of these and other general classroom policies may result in ejection from the classroom under the College's Code of Conduct. Avenues for appealing any such sanctions are outlined in the Code of Conduct.

Lab 200 - Ohm's Relationship

OBJECTIVE

To determine the current *vs* voltage relationships for resistors and diodes.

META-OBJECTIVE

To acquaint (or re-acquaint) students with using Excel to plot graphs in order to analyze data. The Physics concepts used to accomplish this will be covered in greater detail at a later point in the course.

BACKGROUND

Let's make use of an analogy. Consider a fluid in a pipe. In order to make the fluid flow through the pipe, a pressure difference ΔP must exist between the ends of the pipe. As a result, the fluid will move at a rate F (amount of mass passing a given point per unit time) proportional to the pressure difference as described by *Poiseuille's Law*:

$$F = H\,\Delta P,$$

where H is a constant of proportionality that depends on characteristics of the pipe, *e.g.*, its diameter and length, and on the properties of the fluid.

In the same way, the *electric current* (symbol: I; unit: the *Ampère*) can be defined as the rate at which *electric charge* moves past a given point. The *electric potential* (symbol: V or φ; unit: the *Volt*) will be defined later in this course, but for now can be thought of as analogous to fluid pressure. A difference in potential (ΔV) between two ends of an object in which charges are free to move will create a current that is often (but not always) proportional to the potential difference:

$$I = S\,\Delta V \qquad (Eq.1)$$

where S is the *conductance* (unit: the *Siemens*). An object that exhibits this proportional or linear behavior is said to obey *Ohm's Relationship* and is referred to as an *ideal resistor*.

Diodes do not follow Ohm's Relationship. Ideal diodes allow current to flow without limit, but in one direction only. Real diodes have a more complicated behavior that can be approximated with this relationship:

$$I = I_o e^{\Delta V/V_o} \qquad (Eq.2)$$

where V_o is a number that depends on the temperature, composition, and construction of the diode, but is in theory approximately equal to 0.026 Volts for an ideal diode at room temperature.

PROCEDURE

1) Be sure that everything is turned off and unplugged.

2) Connect the circuit as shown in the figure. Use component A on the Component Board as the resistor. One Cen-Tech multimeter will be set to act as the voltmeter and the other to act as the ammeter to measure current. The devices in the circuit are connected using *banana plug* cables. Place one wire into the + (red) terminal of the power supply and connect it to the banana socket on the component board, as shown in Figure 1. Connect the other side of component A to the VΩmA plug on the ammeter. Connect the COM plug of the ammeter to the – (black) terminal of the power supply. Now, connect wires from each side of component A to the COM and VΩmA plugs of the voltmeter, as shown. Before you turn on the power supply, turn the COARSE and FINE voltage control knobs completely counter-clockwise (CCW) and the CURRENT knob completely clockwise (CW). Have your instructor check your circuit.

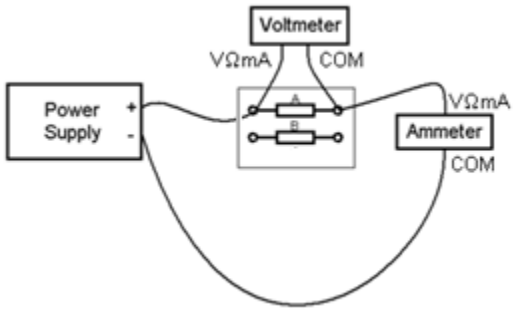


Figure 1 - Set-up for determining the conductance, S.

3) Review the use of a multi-meter before proceeding. Turn the knob on the ammeter to the DCA 200μ setting; this means that the largest current you can measure is 200 micro-Ampères, and that you should multiply the numerical values you read on the meter by 10^{-6}A. Turn the knob on the voltmeter to the DCV 2000m setting; this means that the largest voltage you can measure is 2000 milli-Volts (or 2 Volts) and that you should multiply the numerical values by 10^{-3}V. Determine and record in your notebook the Least Count (LC) values for these scales.

4) Plug in the power supply. Turn on both meters and the power supply. Using only the FINE knob, vary the applied potential difference between 0.1 and 1.0 volts in approximately 0.1 Volt intervals, as measured on the voltmeter (ignore the meter on the power supply). Do not try to adjust the voltages exactly, just adjust the voltages fairly close to the target values and then record the actual values from the Cen-Techs. For each value of $\underline{\Delta V}$, record the corresponding <u>current</u>. For this portion of the lab, you should be able to get all of your current values on the 200μ setting of the ammeter.

5) Turn the FINE knob completely CCW and turn off the power supply. You will obtain negative potential differences by reversing the connections to the power supply. Repeat Step 4 above.

6) Replace the resistor with a *diode* (B on the Component Board) by moving the connections on the black board down one position on each side. Have your instructor check your circuit before the power supply is turned on. Repeat Steps 4 and 5 above, but vary the voltage in

steps of 0.1 Volt to no larger than ± 0.7 V. Record your measurements of ΔV and I. For the diode, you will certainly have to change the scale of the ammeter; do so in such a way as to obtain the greatest number of digits on the readout without overloading the meter, and remember to record the LC values on each scale. When you are done, turn the power supply and the meters off, but do not dismantle your circuit until your instructor has signed your notebook.

ANALYSIS

1) For the resistor measurements, which quantity is your independent variable, current or voltage? Which is the dependent variable? Plot your data using Excel so as to obtain a straight line. Add a line of best fit. What does the slope of the line represent? Determine the experimental value of the conductance.

2) Ask your instructor to determine the expected value of the conductance; you will learn how to do this later, using the colored bands on the resistor. Look at the color of the fourth band on the resistor; this indicates how closely the manufacturer claims to have hit the intended value. A gold band means that the conductance should be within 5% of the intended value, silver 10%, and no band 20%. Record this tolerance value for your resistor. Calculate the percent difference between the value of S you determined from your graph and the manufacturer's expected value. Is it within the expected tolerance? Share your percent difference and tolerance value with the rest of the class. Are all of the class resistance values within the given tolerance?

3) For the diode, which quantity is your independent variable? Which is the dependent variable? Plot your data (using Excel); what shape curve results? Re-plot only the positive voltage points in such a way as to obtain a straight line (review Lab 1 from Physics 1). Add a line of best fit and determine I_o and V_o. Compare V_o to the accepted value given above by calculating a percent difference.

4) Comment on how well each formula ((Eq. 1) and (Eq. 2) above) models the behavior of the corresponding device.

APPENDIX - Using Excel to plot a graph.

1) Open Excel: START → PROGRAMS → MICROSOFT OFFICE → EXCEL.
2) Enter your data in two columns with the independent variable (x) on the left and the dependent variable (y) on the right. Highlight both columns and click the INSERT tab at the top. Choose 'Scatter with only Markers.' The graph should appear.

3) Clean up the graph by removing any unneeded features such as the legend or gridlines. Click the LAYOUT tab. Generally, we don't want GRIDLINES, so remove them. Adjust the scaling of the graph, if necessary, by clicking the AXES button.
4) Label the axes by clicking the AXIS TITLES button. Be sure to include units.
5) When the graph is ready, be sure that it has a blue border around it (if not, just click once on the graph) and PRINT.