# CCBC Spring 2021 SoMS – Physical Science General Physics I - PHYS 151

### CH1-20243

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**General Physics I** serves as the first course in a set of three calculus-based courses in the basic principles of physics for students majoring in engineering, mathematics, or a physical science. The course includes Newtonian mechanics, kinematics and dynamics of translational, rotational, and simple harmonic motions, momentum, energy, and gravitation.

4 Credits: 3 lecture hours; 3 laboratory hours

Prerequisites: MATH 251 with a C or better and (PHYS 101 or Science Coördinator's permission).

### A. Basic Course Information

- 1. Instructor: Dr Dave Baum
- Contact information: Catonsville MASH 016 (443) 840 4341 DBAUM@CCBCMD.EDU (preferred means) Course Webpage: http://faculty.ccbcmd.edu/~dbaum/PHYS151S21/PHYS151S21.htm
- 3. Office Hours: MF 11:00-12:00 & TWR 1:00 2:00 p.m. and by appointment. The Friday hour is *via* Zoom.
- 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 BlackBoard.
- 5. Catonsville Physical Science Dept: 443-840-4560.
- Class Times, Days, and Locations: MW 2:30 5:30 COMBINED LECTURE/LAB 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.Statement of student out-of-class work expectations

- 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, <u>University Physics Vol 1</u>, 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-1.
  - c) The Laboratory Manual is available at the Bookstore.
  - d) A lab notebook (for example, Ampad #26-251, or any quad-ruled 5 to 1" bound composition book) available from almost any bookstore for about \$1. Do not buy the more expensive lab notebooks you may find.
  - e) 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:

- f) The textbook study materials, available at https://openstax.org/details/books/college-physics?Student resources.
- g) A pair of safety glasses may be needed for some labs. Some common-use goggles will be made available.
- h) 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) solve problems analyzing uniformly accelerated motion;
- b) perform vector addition by the graphical and component methods;

- c) apply Newton's Laws of Motion to problems involving force analysis;
- d) develop models from the Force Laws for Work and Energy, Impulse and Momentum;
- e) analyze circular motion;
- f) apply Newton's Law of Universal Gravitation;
- g) apply the principle of Conservation of Mechanical Energy in solving problems;
- h) apply the principle of the Conservation of Linear Momentum in analyzing collisions;
- i) 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;
- j) analyze rotational motion;
- k) apply force and torque analysis to static systems;
- I) analyze simple harmonic motion;
- m) perform a collaborative laboratory investigation;
- n) use computer-based data collection methods;
- o) plot and analyze data using Excel;
- p) evaluate the results of experiments in terms of supporting or disproving theoretical concepts;
- q) search for and find pertinent and reliable information, 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;
- r) write, using MS Word and Excel, coherent laboratory reports that follow the required format;
- s) properly acknowledge reference sources and others' contributions to collaborative work; and
- t) 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) Introduction
    - i. Standards of length, mass, and time
    - ii. Dimensional analysis
    - iii. Problem solving strategies
  - b) Motion in One Dimension
    - i. Linear displacement
    - ii. Velocity
    - iii. Acceleration
    - iv. Freely falling objects
  - c) Vectors
    - i. Vectors and their properties
    - ii. Displacement, velocity, and acceleration in two dimensions
    - iii. Motion in two dimensions
  - d) Laws of Motion
    - i. Newton's first law
    - ii. Newton's second law
    - iii. Newton's third law
    - iv. Frictional forces

- e) Energy
  - i. Work
  - ii. Kinetic and gravitational potential energy
  - iii. Spring potential energy
  - iv. Conservative and non-conservative forces
- f) Momentum and collisions
  - i. Momentum and impulse
  - ii. Conservation of momentum
  - iii. Collisions
- g) Rotational Motion
  - i. Rotatinal kinematics
  - ii. Angular speed and angular acceleration
  - iii. Relations between angular and linear quantities
- h) Law of Gravitation
  - i. Newtonian gravitation
  - ii. Kepler's laws
- i) Rotational Dynamics
  - i. Torque and equilibrium
  - ii. Torque and angular acceleration
  - iii. Angular momentum
- j) Equilibrium of rigid bodies
- k) Oscillations and Mechanical Waves
  - i. Simple harmonic motion
  - ii. Waves: frequency, amplitude, and wavelength
  - iii. Sound and hearing
- 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

- 1. Requirements:
  - 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.
- 2. 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, note that D is a passing grade, although a higher grade may be necessary to enter a given program or to continue with this sequence.

3. 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.

4. 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 " instead of AU. The last day to change to an 'audit' this semester is: February 19<sup>th</sup>, 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 Chapters 1 13 and 15-17.
  - 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) 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.
  - h) This class cannot be recorded without my written permission. A request form is available.

- i) Anyone who is not officially registered for this class may not attend.
- 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 <u>myCCBC</u> 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 <u>CCBC catalog home page</u>.
- 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

January  $31^{st}$  – Drop with 100% Refund Deadline February  $17^{th}$  – EXAM I February  $19^{th}$  –50% Refund Deadline – Audit Deadline March  $10^{th}$  – EXAM II March  $15^{th}$  – May Graduation Application deadline March  $27^{th}$  – April  $5^{th}$  – Spring Break April  $12^{th}$  – EXAM III April  $14^{th}$  –Withdrawal Deadline April  $28^{th}$  – EXAM IIII May  $15^{th}$  – August Graduation Application deadline May  $17^{th}$  – Optional Q Session (4-6) May  $19^{th}$  – EXAM V (2-4) October  $1^{st}$  - Incomplete Makeup Deadline

6. Material in BlackBoard will be available until June 1<sup>st</sup>.

This syllabus may be changed with notification to the class.

List of Full URLs used in this document:

CCBC Catalog: <a href="http://catalog.ccbcmd.edu/index.php">http://catalog.ccbcmd.edu/index.php</a>

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

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

Course Webpage: <a href="http://faculty.ccbcmd.edu/~dbaum/PHYS151S21/PHYS151S21.htm">http://faculty.ccbcmd.edu/~dbaum/PHYS151S21/PHYS151S21.htm</a>

Textbook: <a href="https://openstax.org/details/books/university-physics-volume-1">https://openstax.org/details/books/university-physics-volume-1</a>

Ancilliary materials: <u>https://openstax.org/details/books/university-physics-volume-3?Student</u> resources

### **College Promise: College education that's within reach**

With the Baltimore County and Maryland Community College Promise scholarship programs, college-ready, recent high school graduates can attend CCBC full time without the cost of tuition and fees.

As "last dollar in scholarships," the Baltimore County and Maryland Community College Promise scholarships cover tuition and mandatory fees for eligible students after applying all other financial awards—such as Pell grants, state aid and scholarships.

Awardees may apply the scholarships to a degree or credential sought at CCBC. Students still need to cover other costs such as books, transportation, supplies and materials.

http://www.ccbcmd.edu/Costs-and-Paying-for-College/Help-Paying-for-College/Scholarships-and-Grants/Promise-Program.aspx

### Get on the right PATHWAY!

Based on declared majors or main areas of interest, incoming CCBC degree — and certificate — seeking credit students are grouped into one of six Pathways:

- Arts
- Business, Law and Education
- General Studies
- Humanities and Social Sciences
- Science and Health Careers
- Technology, Engineering and Mathematics

Based on your Pathway, you will receive assistance in course selection as well as student success supports and activities that are geared toward successful degree and certificate completion, transfer and career success.

http://www.ccbcmd.edu/Programs-and-Courses/Degrees-and-Certificates/Pathways.aspx

Is campus closed?

Find out before the news stations with CCBC Campus Alert.

Campus Alert is a free messaging service\* for the CCBC community that keeps you posted when any part of the college is closed.



www.ccbcmd.edu/campusalert

Might be **bad weather**. Could be a **utility outage** or some other type of **emergency**. Either way, campus alert is a smart and convenient way to get the news and stay safe.

### CCBC Campus alert is ideal for:

- Students
- Parents and other family members
- Faculty and staff
- Community members who use CCBC facilities

It's flexible. Campus Alert lets you know what's going on via your choice of:

- Text message to your mobile phone
- Voice call to any phone
- E-mail

*It's customizable.* You can choose any combination of these contact methods and specify multiple phone numbers or e-mail addresses to make sure you never miss the alert. You can even include contacts for family so that they know what's going on. Plus, you can pick which CCBC campuses and extension centers you want to hear about.

*It's private*. CCBC uses the system only for emergency campus alerts. Period. And we protect your contact information and will not share it with anybody. Ever.

## It's easy to sign up.

Just visit www.ccbcmd.edu/campusalert to learn more and register online now.

\* There is no fee to sign up for Campus Alert. However, standard text message and mobile voice rates will apply depending on your service agreement with your mobile carrier.

- CCBC		
<b>Thank you for sharing this important message.</b> Together we'll make sure our students "make the grade and save their aid!"		<ul> <li>Audited courses are not eligible for financial aid.</li> <li>An incomplete grade is not considered "passing" until the student completes all required work to earn a letter grade of "A - D."</li> </ul>
A completion rate of at least 67 percent of attempted coursework in both credit and billable hour courses is required. That means earning an "S" (Satisfactory) in Developmental Education courses and an "A - D" grade in credit courses.	•	If a student chooses to withdraw, audit or take an incomplete grade in any course, his or her SAP will be affected. Please encourage any student considering one of these options to visit the Enrollment Services Center (ESC). The ESC will advise the student of how the withdraw, audit or incomplete will impact financial aid. Please note the following:
1-18 1.50 19-31 1.75 32-44 1.85 45 or more 2.00		When financial aid is suspended, the student is required to pay his or her tuition, fees and books until the required financial aid SAP standards are met. A student may only appeal if there are extenuating circumstances that can be documented. Many of our students will be unable to cover their educational expenses, so let's work together to help them understand how to maintain their financial aid eligibility.
maintain financial aid eligibility: If the student attempts Minimum (credits/billable hours): GPA requirement	<b>p</b>	You have the most direct contact and influence with our students. Please help them understand the importance of maintaining financial aid Satisfactory Academic Progress (SAP). These SAP standards include GPA and course completion. (See reverse.) <b>Students who fail to meet these standards will lose their financial aid eligibility</b> .
Minimum GPA requirements to		We need your help!
<ul> <li>during the Spring 2012 semester)</li> <li>CCBC Dundalk - Building A</li> <li>CCBC Essex - Building A</li> <li>Call 443-840-CCBC (2222)</li> </ul>		Federal regulations require students to meet GPA and course completion standards, and <b>many students may be in jeopardy of losing their financial aid</b> . Without financial aid, some students will be unable to continue their studies at CCBC. This is a serious concern, as <b>more than half of our students depend on financial aid</b> to help fund and achieve their educational and career goals.
<ul> <li>Visit the student portal, myCCBC, to check grades and financial aid information.</li> <li>Go to www.ccbcmd.edu/financialaid/makethegrade.</li> <li>Stop by the Enrollment Services Center:</li> <li>CCBC Catonsville – Building F (temporary location</li> </ul>		What every CCBC faculty and staff member needs to know.
Where to direct students for information and help:		SAVE YOUR AID!
MAKE THE GRADE SAVE YOUR AID!		MAKE THE GRADE

3

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# What to do in an Emergency CCBC PUBLIC SAFETY

Extension 1111 OR (443) 840-1111

# **BALTIMORE COUNTY POLICE OR FIRE - 911**

Active Shooter	Medical Incident	
<ul> <li>Run from the sound of gunfire without delay</li> <li>Hide from the shooter if you can't escape</li> <li>Fight the shooter if you must</li> <li>Your life and safety is most important.</li> <li>Do what you must to protect yourself, and get away from the danger immediately</li> <li>Call 911 to report the incident</li> <li>FBI Video: Run. Hide. Fight. Surviving an Active</li> <li>Shooter Event:</li> <li><a href="http://www.fbi.gov/about-us/cirg/active-shooter-and-mass-casualty-incidents/run-hide-fight-video">http://www.fbi.gov/about-us/cirg/active-shooter-and-mass-casualty-incidents/run-hide-fight-video</a></li> </ul>	<b>Call 911</b> to report a medical emergency, including unconsciousness, cardiac or breathing problems. Give your campus, building and room location to the dispatcher. <b>Call Public Safety at 443-840-1111</b> for immediate assistance. Stay with the person and offer assistance.	
<b>Classroom Disruption or Fight</b>	Fire or Building Evacuation	
Call <b>443-840-1111</b> or <b>911</b> for assistance. Provide the campus, building, and room location. Provide information regarding weapons and a description of participants. Do not try to stop the fight yourself. Quietly encourage others to leave the room.	For fire or smoke in the building, <i>pull</i> the nearest fire alarm. <i>Shut off</i> gas valves, leave the building, and <i>assist</i> <i>others</i> in the evacuation. <b>Contact 911</b> with your observations and number and location of the injured. <i>DO NOT</i> go back into the building.	
<b>CCBC</b> The Community College of Baltimore County As soon as an earthquake or tremor is detected and confirmed, leave the building promptly and move to an open area where a building collapse will not harm you. Take others with you and <b>DO NOT</b> re-enter the building until you are cleared to do so.	Classroom Decorum Classroom disruptions are minimized when students and staff work in a cooperative, orderly environment. The following rules must be followed to prevent classroom disruptions: 1. Food and drinks are not permitted in classrooms	
<ul> <li>Classroom Communication Methods</li> <li>When calling for assistance,</li> <li>1. Use a college phone to call x1111 or 911</li> <li>2. Use a cell phone to call 443-840-1111 or 911</li> <li>3. Use the EMERGENCY call box in the hallway on each floor to reach Public Safety</li> </ul>	<ol> <li>Cell phone ringers must be turned off (vibrate only)</li> <li>Electronic devices are permitted with <i>instructor permission only. ALL</i> devices <i>must be turned off</i> during testing.</li> <li>Electronic cigarettes are not permitted. They follow the same restrictions as other tobacco/smoking products.</li> </ol>	

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*. All laboratory objectives, equipment lists (include model and serial numbers), procedures, techniques, 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 printed by computer or drawn on loose leaf graph paper 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. While all this may seem rather AR, the student must realize that, at the least, a notebook must be capable of reminding him of his procedures and results in case he must repeat them or if his work is questioned, and at the other extreme could be the factor determining who gets credit for a patent or other discovery. A good self test if enough information has been included is to ask whether a friend at some other school could duplicate the experiment using just the notebook and lab manual.

Lab #	Date	Title	Instructor's Signature
01			
02			
03			

- The grade for the lab portion of the course will be based on formal reports (5 points, due typically one week after the exercise) and the notebook checks (5 points). 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 generally 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.
- Reports for Summer Session classes will be somewhat less formal and will be due without exception at the end of the lab period. Once the reports are returned, you have two class days to bring any questions or complaints to the instructor's attention; after that, the grades are finalized. You *may* be asked to use the Physics Laboratory Report Form available separately on line; if so, *remember to bring a copy of the Physics Laboratory Report Form with you to Lab Class.* Otherwise, word processing facilities will be made available for the final hour of lab classes.
- Student Name Title Date Names of Partners
- Objective of Experiment The objective is often to verify some relationship which was presented in class. In these cases, a brief discussion of the concept is required, along with an outline of how this experiment will support (or disprove) it.
- Description of Experimental Apparatus A labeled schematic sketch is often enough for the reports. Artistic renderings of the apparatus are inappropriate. Notebooks should include model and serial numbers, scale settings, *et c*.
- 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. The goal is that the available information should
  be specific enough that another student taking PHYS I could reproduce the experiment. In
  particular, any steps with may be considered novel or unusual should be documented in
  detail.
- Data (if appropriate) For reports, it is a judgment call as to how much raw data are included. Often, data can be presented in the form of a graph more efficiently than as columns of numbers. In the notebooks, however, all data should be recorded in some way, if at all possible. All measurements must be accompanied by an estimate of the uncertainty in that measurement. It may be that the student will not be asked to propagate the uncertainty through to the result, but at least the necessary information will be available. Again, do not disassemble your apparatus until your instructor gives permission.
- Results Results often call for comparison of the student's answer to some accepted value; generally a *per cent difference* can be calculated, or a check can be made to see if the accepted value is within the uncertainty of the experimental result. Other times, a particular relationship among variables may be found by graphing. Results should be clearly indicated.
- Conclusions This can often be combined with the results section. 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?

- The reports should be typed, although figures may be hand-sketched and graphs may be handplotted on commercial graph paper. Obviously, Summer Session reports can be handwritten. 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, without the pretentious use of synonyms (e.g., 'use' and 'utilize' do not mean the same thing). Philosophical digressions into the nature of the universe or questions about whether the reports are actually read are not appropriate. 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, either because the equipment is worn or broken, or because the experiment is truly illconceived. We can only assure the student that members of the department have 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 will 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 sign into the lab and 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 100 – Learning Excel

#### OBJECTIVE

To learn to use Excel to make graphs and do simple calculations.

#### BACKGROUND and PROCEDURE

- Microsoft's Excel is a popular and fairly powerful spreadsheet program that can be used to analyze and graph data in the laboratory. Other programs include OpenOffice Calc (which has the advantage of being free) and Corel's Quattro Pro. Note that the references to menus and commands below are for Office 2013's Excel.
- 1. Making simple graphs is quite straightforward in Excel. On the Physics computer desktop, click on the 'Lab 0' icon. When the spreadsheet opens, you will see in Part 1 a graph that is already completed, based on the data in the table on the left (cells A8-B15). Note that the axes of the graph are labeled and that the units for each axis are clearly indicated. The line that is drawn through the points (not connecting them) is a *least squares linear best fit line*, that is, it passes as close to all of the points as possible. The equation on the graph is the equation of the best fit line. Note that if you change any of the values in the table, the graph automatically updates itself. Try it.

This is a good time to learn a useful shortcut: Pressing 'Ctrl' and 'Z' at the same time undoes whatever action was just taken. Try it and see if the graph returns to its original state.

2. Now, you make your own graph. In the section labeled Part 2, enter the data below into cells A24-B32. Generally, the variable you control, the *independent variable*, goes on the *abscissa* (or 'x-axis') and the resulting *dependent variable* values are plotted on the *ordinate* (or 'y-axis'). There are some exceptions to this rule that will be discussed at the proper time. Excel likes to have the x-values in the left-most column, with y-values in succeeding columns to the right. Enter these data into the table in Part 2, assuming that you control the temperature and you measure the resistance:

Temperature	Resistance
(Kelvins)	(Ohms)
262	3294
274	3445
280	3520
293	3684
301	3785

Which quantity is the independent variable? Which then goes in the leftmost column?

To generate the graph, use your cursor to highlight the data you have just entered. Click the INSERT tab at the top of the screen and choose the SCATTER option. A small window will drop down and you should usually choose the option that has no lines, just data markers. At this point, you should see your graph with a light blue outline around it. Generally, you will not need a legend, so right click it and delete. You should also get rid of the horizontal and vertical grid lines; right click on one of them and delete.

Now, insert the best-fit line into your graph. To do this, right click one of the data points and choose ADD TRENDLINE. Normally, you will want to tick the LINEAR box as well as the DISPLAY EQUATION ON CHART box. Close the menu pane by clinking the [X] at the top right.

Now, label your axes. Click on the CHART TOOLS/DESIGN tab at the top and choose the ADD CHART ELEMENT pull-down menu. Choose AXIS TITLES/PRIMARY HORIZONTAL. A small box should open under your x-axis containing the words AXIS TITLE. Place the cursor in the function box (to the right of the ' $f_x$ ' symbol) and type the name of your x variable, including the units used. In this case, you would type 'Temperature (Kelvins).' Return to the ADD CHART ELEMENT pull-down menu and choose AXIS TITLES/PRIMARY VERTICAL. A small box should open next to your y-axis containing the words AXIS TITLE. Place the cursor in the function box and type the name of your y variable, including the units used. In this case, you would the words AXIS TITLE. Place the cursor in the function box and type the name of your y variable, including the units used. In this case, you would type 'Temperature the words AXIS TITLE. Place the cursor in the function box and type the name of your y variable, including the units used. In this case, you would type 'Resistance (Ohms).' At this point, your simple graph is probably complete.

3. Often, you will need to repeat the same calculation many times, but with different numbers. In Part 3, you will learn a few commands to do these calculations. Every calculation formula must begin with an equal sign (=). Operators for addition and subtraction are obvious (+ and -), multiplication is indicated by an *asterisk* (\*), and division by a *virgule* (/). Numbers are raised to a power with a *caret* (^) and the square root taken with the SQRT command. For example:

Math operation	Excel formula
Three times six	=3*6
Four plus three	=4+3
Seven divided by five	=7/5
The square root of six	=sqrt(6)
Seven cubed	=7^3

Trigonometric functions are fairly obvious, except that the angle must be in radians, not degrees. Pi ( $\pi$ ) is written in a very strange way: pi(). So, either convert the angle in degrees to radians yourself, or use the RADIANS function in the formula. For inverse trig functions, the angle is returned in radians, and you must either convert the result to degrees yourself, or use the DEGREES function (see examples below). Generally, Excel follows the same order of operations you learned in high school, but it never hurts to add a few more parentheses. So,

Math operation	Excel formula
3 times π	=3*pi()
The sine of 45°	=sin(45*pi()/180)
	OR
	=sin(radians(45))
The arctangent of 3 (in degrees)	=(180/pi())*atan(3)
	OR
	=degrees(atan(3))
3 + 4 x 5	=3+4*5
$(3 + 4) \times 5$	=(3+4)*5

In the cells in Part 3 (A38-A41), calculate the following:

$$6+5\times 3$$

$$7-4^2 \div 3$$

$$3 \sin(30^\circ)$$

$$4 \sqrt{\frac{4+3}{3^3}}$$

4. You will often be asked to find the average and standard deviation of a set of numbers. Find an empty cell and type '=AVERAGE(' and then highlight the numbers you want to average. Close the parentheses and hit ENTER. The average will appear. The standard deviation is similar; type '=STDEV(' and highlight the numbers. As examples:

Math operation	Excel formula
Average of cells A25 through A38	=average(A25:A38)
Standard deviation of cells F17 through F42	=stdev(F17:F42)

In cell D46, calculate the average of the numbers in cells A46 through A50. In cell D47, calculate the standard deviation of the numbers in cells A46 through A50.

5. Often, you will be required to repeat a calculation many times. Excel is very good about this if you can set your cells up correctly. Suppose that you want to find the volumes of a number of cylinders whose dimensions are given in the table in Part 5.

$$Volume = \frac{height \times \pi \times (diameter)^2}{4}$$

Rather than do the calculation eight times, do it for the first set of numbers only. Click on cell C55. Start your command with an equal sign, as always. Now, instead of typing 1.2, click on the value you want in cell A55, then type an asterisk for multiplication, then the symbol for pi, another asterisk, highlight cell B55, type a 'caret 2' to square the diameter, and finish with a virgule and then the number 4. When you are done, the cell should look like this:

It couldn't hurt to add some parentheses for clarity:

Hit 'ENTER' and the value of 19.085 should appear.

Now, instead of typing this in seven more times, Excel can redo this calculation for you. Click on cell C55, then move the cursor to the lower right corner of the cell. You will see it change shape from a thick cross to a thin cross. Click the cursor and drag it down to cell C62, then release. You should see all the volume values in their proper places.

#### ANALYSIS

Your instructor will be following your progress as you work through this exercise. When you are done, print two copies of your spreadsheet. One will be turned in for credit as your report for this exercise, the other should be stapled into your lab notebook.