Syllabus for University Physics I (PHY 211 – Section 202 – CRN 4380) – Spring 2024

Lecture: Science Building, Room 277 – (MWF: 10-10:50 am) & (W: 11-11:50am)

Course Description: This is a face-to-face, in person, 4-credit hour, lecture format, introductory physics course that requires the use of algebra, trigonometry, calculus, and vectors to solve real world problems and is required to be completed in one semester. The W: 11-11:50 am is a double lecture day. From the most recent course catalog available: PHY 211 is the "First half of an introduction to physics for physical science and engineering students, using calculus, and including kinematics and dynamics, force, energy, rotation, fluids, waves, and ~~thermal phenomena~~." Topics related to thermal phenomena have been eliminated as a result of the reduction to a 14-week semester, the course catalog statement has been requested to be updated each year. This course will mostly focus on Newtonian Mechanics, Work-Energy relationships, Oscillations, Waves, Fluids, and Deformation of Materials. No extra credit will be available for this class and there will be no dropped grades, everything counts. It is expected that you have a high school level background in algebra and trigonometry and/or geometry. The Physics Program is currently housed in the Department of Mathematics and Physics within the College of Science.

Program Required Textbook: **"University Physics with Modern Physics" by Young and Freedman, 15th Ed.** We will use chapters 1-16 and some of chapter 17. Check out the below link for available formats for the above textbook: e-Text, paperback, hardcover, loose-leaf versions, etc. https://www.pearson.com/store/p/university-physics-with-modern-physics/P100002510958/9780135216118. The format of the textbook will **NOT** matter for this course, e-text is probably the cheapest. MasteringPhysics will **NOT** be used in any capacity for this course, do **NOT** purchase MasteringPhysics for this course. The above book contains all the necessary physics topics that will parallel this course lectures. A detailed schedule of the course lectures and topics is provided at the end of this syllabus with the corresponding chapters and sections based on the above program required textbook. That being said, any introductory calculus-based physics textbook will also likely have all the same exact topics, the physics does not change depending upon the book, so any calculus-based introductory physics textbook will likely suffice for this course. Lecture notes and homework are **NOT** specifically tied to a particular textbook. With that being said, it is best to use the notation learned from the lecture notes for all homework, quizzes, and exams. A suggested **FREE** online textbook is found at: https://openstax.org/details/books/university-physics-volume-1. If a student chooses to use any textbook other than the program required textbook, the student is responsible for reading the correct sections of their chosen textbook that parallels the class lectures for the listed **required readings** found in the schedule at the end of this syllabus.

Co-requisite Courses: MTH 229/229H - Calculus with Analytic Geometry I & PHY 202 - General Physics I Laboratory.
(Biomedical & Electrical and Computer Engineering majors do not need to take PHY 202)

Course Instructor Info: Dr. Sean P. McBride**,** Science Building 152/152A, (304)-696-2758/8852, mcbrides@marshall.edu
''HERD Hours'' and Office Hours: (**F** 9-10 am, 11-2 pm, and 3-5 pm)
- Additionally, I have an 'open-door' policy for office hours as well as an 'email me anytime with questions' policy.

Teaching Homepage: http://www.science.marshall.edu/mcbrides/teaching/
Research Homepage: http://science.marshall.edu/mcbrides/

Academic Calendar: For drop/add dates, last day to withdraw from classes, and other important semester dates, see the Marshall University Academic Calendar (http://www.marshall.edu/academic-calendar/).

Objectives: All material covered in this course is geared toward students pursuing a degree in the physical sciences or engineering. For the engineers, this course is aimed at showing you the basics of physical phenomena that you will study later in greater detail in your engineering courses. For example, studying systems that do not move (statics), moving objects (dynamics), and fluids are each limited to several chapters in this class; however, you will spend entire semester long courses devoted to studying each of these individual topics in greater detail during your engineering career. More specifically, the objective of this course is designed to provide you with a basic understanding of: units, vectors, motion in one, two, & three dimensions, velocity, acceleration, conservative & non-conservative forces, work, kinetic energy, potential energy, conservation of energy, momentum, impulse, collisions, periodic motion, mechanical waves, sound, rotational motion, systems in mechanical equilibrium, elasticity, thermal expansion, and the basics of fluid mechanics; these are all key aspects of science that form some of the fundamental foundations of the physical world that surrounds us every day.

This is a very organized class. This is a fast-paced course, ~ 16+ chapters in 14 weeks; do not fall behind, if you do fall behind, seek help immediately, plenty of options for help exist, see page 2 of this syllabus or my Teaching Homepage for useful links. It is recommended that you get at least a 2-inch binder and a hole punch and keep all your materials organized to study from.

Learning Outcomes: In the process of learning the fundamentals of physics as described above, **the overarching goal of this class**, independent of your major, is to help hone your critical thinking, analysis, problem solving, and quantitative reasoning skills. To accomplish this goal successfully, you will be given **practice** via written homework problem sets that will be due weekly. Your individual success in achieving this goal will be **assessed** by your performance on weekly in class quizzes (10 of them - 5 group quizzes and 5 individual quizzes), 4 in class examinations, and a cumulative mandatory Common Final Exam.

Help for This Course: If you are starting to experience difficulties in this class, there exist many resources available for you to obtain additional help. *Resolve these difficulties quickly, before they snowball out of control (~16+ chapters in 14 weeks). If you are lost in weeks three or four it may be very difficult to recover, ask for help sooner.* I am your number one resource for help in this class.

- ***Six Office/*** ''HERD Hours'' ***per week*** (**F** 9-10 am, 11-2 pm, and 3-5 pm S 179/152): Get help in a group of friends or 1-on-1 individually, or we can make an appointment if these Office/ ''HERD Hours'' times do not work for you. Or, you can simply drop by the Science Building to room 152 at any time, and if I have additional time to help you and my door is open, I will. Feel free to email me questions at any time as well, I am usually quick to respond during the week and when it is within reasonable hours. It is very important that you ask questions as soon as you do not understand something. It is suggested to make friends with other students in the class and come to ''HERD Hours'' and study for Quizzes and Exams together.

- ***There are free university tutors available for PHY 211***. See current tutoring options available at: http://www.marshall.edu/uc/tutoring-services/. I personally have not vetted or approved any of the Knack tutors, be cautious; first give ''HERD Hours''' a try or drop by my office. I also provide a list of "Dr. SPM Approved Tutors" on my Teaching Homepage that I will vouch for (they are private tutors, you pay by the hour). Additionally, the Physics Majors have been known to offer free tutoring in the Science Building each semester as much as possible; more information on times will be provided when information becomes available (please contact Administrative Associate, Teresa Wellman, for more information: wellmant@marshall.edu, this information when available will be posted on my teaching website).

- ''HERD Hours'': You are all encouraged and welcome to come to what I call ''HERD Hours'', this is an environment where students can come individually, or especially in groups, and ask questions. This is in the ***Science Building room 179 from 9-10 am, 11-2 pm, and 3-5 pm on Fridays***. Come and work on homework together in a non-classroom and/or non-typical-professor-office-hour setting. At ''HERD Hours'', I will be around to help you at any time if you get stuck (my office/lab is right across the hall, S152), but what I really want to see is students helping fellow students, leading each other through peer instruction. Struggling, discussing, conquering the problems, and celebrating with your friends and peers is better than being frustrated by yourself and not making progress on the homework. I encourage you to work together. When working in groups there are more people around the table with different skill sets and different approaches and ideas to attack the problems. Working together in groups often results in getting the homework done faster with a better understanding and is overall a more memorable experience than spending long frustrated isolated hours struggling on your own. Simply copying the homework from your peers during ''HERD Hours'' or other unauthorized resources will be of no benefit to you as 70.5% of your grade will come from individual exams and quizzes. Attendance will be taken during ''HERD Hours'' for recording keeping purposes only, **not for extra credit.**

- ***PhET Simulations:*** Remember, physics is some hard stuff when seeing it for the first time. I will try to introduce demos into the lecture to help assist in conveying the concepts; however, PhET Simulations are another good tool to 'see' concepts in action. PhET Simulations (https://phet.colorado.edu/en/simulations/category/physics/index) are interactive apps that highlight or demonstrate a physical concept. Outside of class, go online and play with the parameters in these simulations and see how changing the variables changes the results. You can even use the simulation to make tests and quiz problems for yourself. To run the PhET Simulations, use the latest version of Mozilla Firefox as your browser (https://www.mozilla.org/en-US/firefox/new/) combined with the latest version of Java found at http://java.com/en/ (some still run on using Adobe Flash). Then select the simulations directly from the web site. Visit https://phet.colorado.edu/en/troubleshooting, if you experience problems or cannot open/run the PhET simulations.

Advice: **As you can see above, there are many avenues and options for help. Don't be afraid to get help early.** If you do any of the homework/quiz/exam problems incorrectly, it is your responsibility to learn how to do them correctly, learn from your mistakes, that is why you are here. Solutions to everything will be posted on Blackboard, and I am mostly always available if you need help. If you see something once in my class, chances are you will see it again for a higher point value on a later Quiz/Exam. It is beneficial to rework all problems you got wrong on Written Homework, Quizzes, and Exams. Similar problems could also be on the Final Exam. Physics is a subject where **memorization techniques will NOT work**; this is why it is often perceived as a difficult subject by many. To be successful in this class, understand the individual concepts and how they relate to say your favorite example; then be able to apply that concept to many other different problems and situations (the circumstances and required math for each problem may be different, but for each, the concept and approach leading to the answer is the same). The homework is time consuming and challenging, but that is rightfully why it makes up 15% of your grade. To do well in this class, you will have to spend ~ 12 quality hours per week dedicated to this class. Your understanding is proven by your individual quiz and exam performance, which make up a higher percentage of your overall grade. You must be able to demonstrate/understand the concepts from homework or else you will fail the quizzes. If you fail the homework and quizzes, you will fail the exams, including the final common exam, and thus the course.

Attendance: I view all university level students as adults, who can or must do adult things, such as drive a car, vote, pay taxes, and who can also be sentenced to jail as an adult. Thus, as adults, I expect you to be responsible and be in class at all scheduled meeting times; however, you will not be docked points if you have an emergency and have to miss a normal class when homework is not due or there are no quizzes/exams for that day. Simply get the missed lecture material from a willing classmate or Blackboard. Keep in mind there is a strong correlation between in class attendance and quiz/exam performance. All exams/quizzes/homework are mandatory and must be taken in class/(turned in) on the provided dates according to the schedule at the end of this document. If you are absent you still must turn homework in early and make up any assignment if allowed. Notify me immediately when you realize a conflict exists when homework is due, there is an exam, or a quiz so we can come up with an alternative plan in advance (check the tentative exam schedule at the end of this document for exam times now). If no effort is made in advance, the assignment/quiz/exam may count as a zero. All students are responsible for all lecture and demo material that occurs in class. Within the first 2 weeks of class, all students involved in any official Marshall University sports team or club (including accompanying Band/Dance/Cheer/Flag/etc members of any kind) must provide a schedule of when regular season events occur and be signed by a supervisor with contact info provided. **If you know well in advance when you will miss something, notify me immediately.** To help curb recent spikes in frequent absenteeism without a University Excused Absence we will follow the below point deduction scheme. You must sign the attendance sheet that is passed around each class period.

0 - 4 missed normal classes for whatever reason = no point deduction.
5 missed normal classes with no University Excused Absence = 5% off overall grade.
Every normal class beyond 5 missed classes with no University Excused Absence will be an addition 1% off your overall grade.
10 missed normal classes with no University Excused Absence will result in an automatic failure of the course.

Lectures: Ideally, lectures will contain exciting demonstrations where possible that will illustrate the physical concepts being taught. Lectures will also provide you with the background to solve real world problems (mathematical machinery will be given through examples). Ideally, all the aforementioned topics will be covered. Some topics might have to be omitted due to unexpected and unforeseen circumstances that may arise throughout the semester (floods, power outages, snow storms, ice storms, global pandemics, etc). A very detailed tentative course schedule is found at the end of this syllabus with all the tentative exam, quiz, dues dates for written homework, an up-to-date list of topics covered, etc, etc. Dates may change on this printed tentative course schedule; thus, see the most up to date syllabus in Blackboard.

Required Reading and Purpose of Lectures: It is required that you read the sections of your textbook that are outlined in the tentative course schedule at the end of this syllabus. You should certainly read the corresponding sections prior to attempting the homework, quizzes, and exams. The lectures are geared toward the average student and primarily meant to (1) spark an interest in the subject, (2) highlight key and often difficult parts of the text, (3) show exciting demonstrations of the concepts discussed in the text where possible and if available, and (4) work through some examples to give you the mathematical machinery to solve problems. It is recommended that before or after class, you download any additional notes or videos from Blackboard and review them before the next class. Read the book. Study your book and your homework, study the provided solutions, your lecture notes, my posted lecture notes/videos, your previous exams/quizzes/ and solutions, and ask questions!

***Grading*:**	End of the Semester Assessment Test (ESAT)	2%†
	Common Final Exam	15%
	Written Homework:	15%
	In Class Weekly ~ 20/30-minute Quizzes:	20%
	In Class Exams (4 total, 12% each)	48%

***Determination of Final Grade*:**	90% or above:	A
	80% or above:	B
	70% or above:	C
	60% or above:	D
	59.9% or lower:	F

***** I reserve the right to adjust these percentages and letter grade cutoffs based on the overall class performance, or individual assignments, thus stay above the average grade of the class and assignment average to ensure an above average grade in the class. Any potential curve for the class or assignments will be based only on only students that participate in all parts of the class or the specified assignment. Typically, but not in all semesters, the top student has a final grade close to 100% after an applied curve and the average/median final course grades after an applied curve ends up being near 75%. If you are below the average/median grade, chances are you will receive a below average grade. If you are above the average/median grade, chances are you will receive an above average grade. The number that actually represents the average/median is irrelevant. Typically, but not guaranteed, letter grade breaks at the end of the semester are roughly 5 points below those stated above. An average letter grade is a 'C'. Grade distributions will be given frequently in Blackboard so you know exactly where you stand at any point in the class relative to your peers. Previous class distributions from previous sections of PHY 211/PHY 201 are located on my Teaching Homepage: http://www.science.marshall.edu/mcbrides/teaching/. Email me at any time to find out your exact class rank relative to your peers.

† You must take both the pre and the post ESAT to get the 2%. Taking just one or the other earns 0%.

Remember, physics is some tough stuff. Regardless of the number that represents the course average/median, you always want to stay above this average course grade relative to your peers to achieve an above average grade in the class. An average grade is a 'C'. Grade example: before the Final Exam and ESAT are included, if you're getting 90% of all the homework correct and getting a 50% on the in-class exams and quizzes, you are only pulling a ~ 57.2 % for the course. Acing the homework does not equate to passing the course. The average for the course maybe a 75%, which means you are doing well below average relative to your peers, seek immediate help to get ahead of the class average with the aim to earn an above average grade. See **"How to write-up my physics solutions on homework and exams?"** or the **"Example Written Homework Solution"** on Blackboard to get the most points on the written homework, quizzes, and exams. See also the **"How To calculate Your Grade"** example in Blackboard. An attempt will be made to post class averages, medians, and distribution plots before and after each exam to let you know exactly how you are doing relative to the rest of the class.

Calculators: No programmable/graphing calculators are allowed during quizzes or exams (No TI-83 through TI-Nspire CX and beyond for example). Get a simple TI-30 or TI-35 for example (model numbers and brands may vary, but you get the idea). Or, better yet get the same calculator you will need for Engineering 111 if you have to take that class (Casio fx115ES Plus or fx115 ES, not the MS or MS Plus, check with your Engineering professor). Do not buy it the night before the exam, or do all the homework with a TI-89 or a TI-Nspire CX, and then try to switch to a TI-35 for the exam, neither of these will go well for you, guaranteed (I have witnessed multiple times students that could not turn on new calculators or figure out how to convert fractions to a decimal answer, I will not be able to help with that during an exam). My advice is to learn how to use your simple calculator early and stick with the same one for the homework, the quizzes, and exams. **Cell Phones are NOT allowed to be out and must be turned off or put in silent mode during exams and quizzes, therefore, calculator cell phone apps are NOT allowed.**

Electronic Devices: All cell phones, headphones, air buds, laptops, I-pads, smart watches & other communication devices, etc., should be turned off/silenced and should **not be used at any time during class and exam/quiz time**; if a phone or similar device is out during an exam or quiz, **you earn a zero for the exam or quiz, no questions asked**. If your cell phone or other electronic device is out during class time and is distracting/effecting others ability to learn, and you do not sit in the back of the class you will be asked to leave the classroom. If you use a laptop to take notes, please sit in the back of the class so as to not distract others around you. If you must use a large electronic device for note taking, please sit in the back as to not distract those around you. Understand, three different versions of the notes will be posted for each lecture including a video with audio.

COVID-19 – Previous, new, or developing information is assumed to posted here: https://www.marshall.edu/coronavirus/

The 1-Week Rule: I am happy to fix any grading errors. Any grading disputes or grading mistakes needs to be brought to my attention within one week of when the assignment was distributed or made available to the entire class. After 1-week from this date, regardless if you did not attend class to receive your graded assignment, grades are permanent. Your must turn your assignment back in to be regraded. You must write a cover page or write on the top of the assignment on the first page what problem needs regraded and why. It is advisable to take a picture of your work before turning back in for a regrade. Any attempt to alter a previously graded assignment in any way, such as adding information to it, removing information from it, or simply altering the previously presented work for a better grade is considered Academic Dishonesty and will be treated as such. Regrades will be returned any time before the end of the semester and are often very delayed in getting returned due to current grading taking precedence over regrades and there being limited time for grading.

Homework Extensions: **Late homework is simply not accepted even if you have a University Excused Absence.** Homework will be due every week at the same time, Monday, beginning of class, plan accordingly. If you have to miss class on Monday (for whatever reason), plan to turn the written homework in earlier, not later (scan the assignment and email, use a quality app to scan homework or find an actual scanner). If needed, CamScanner works well (https://www.camscanner.com/). Turn in the missed assignment as a single pdf document. Multiple pdfs or pictures will not be graded. Independent of all factors, once homework solutions are posted after class, any late homework received, for any reason will not be accepted or graded. Homework exemptions are only given in very rare circumstances, requiring documentation and must be a qualifying event (see Emergencies Section regarding university excused absences at the end of this syllabus).

Written Homework: For your homework, always try it yourself first; however, you are all encouraged (but not required) to discuss it with your peers for help. A great place to do this is at ''HERD Hours'' where students are encouraged to come to the ***Science Building room 179 from 9-10 am, 11-2 pm, and 3-5 pm on Fridays,*** either individually or especially in groups or herds, to come and work on homework together in a non-classroom and/or non-typical-professor-office-hour setting. Your peers (N ~ 15 - 50+) significantly outnumber the number of the professors for this course section (N = 1) and they may be more available than your professor to help you. I encourage students to discuss homework with each other if you arrive at different answers. If you think the answer you got is correct, and you are confident in your solution, try and explain it to your fellow students, use the chalkboard, write it out, see what they think. Maybe they solved the problem a different way, arriving at a different answer (or the same), encouraging you to review and rethink how you solved the problem. Hopefully this encourages discussion of physics among you and your fellow students and builds your confidence in problem solving and improves your ability to explain your work to others. If you cannot get the required help from your peers, or simply have a question, come see me anytime, email me, and/or make an appointment with me, and/or apply for a tutor. You must pick up the new homework problems sheets in class on Monday (the questions will only be posted after they are due). Extra copies will be placed in the bin attached to my office door (S152) if you lose or misplace your original; they will not be emailed over the weekend or at other time before they are due.

8-15 problems per week. Anywhere from 0 to 4 of the problems may be randomly chosen out of the total number of problems to be graded in detail. If no problems are graded in detailed you will be given a score based on your effort and completion of your work. If not graded in detail, some problems may be graded for just correctness, or for just completeness (independent of correctness), or simply not graded at all depending upon the resources available during the semester. Note: I very much dislike the fact that you do not get all your homework problems graded, but it is impossible to grade ~ 400 – 750 problems in detail per week for a full class with little-to-no support staff. After solutions are posted, rework the problems you got wrong, make sure you understand all the problems regardless of your grade. Written problems are due at the beginning of class on Monday each week (if the university is closed on Monday due to a holiday or weather, it will be due on Wednesday of that same week, or the next scheduled class day the university is open). New problems will be given in return on Mondays or the next time the class meets when the university is open. It is advantageous to take pics of your homework before turning in to study from, especially on exam weeks. More points will be awarded for more difficult/longer problems, total points per assignment may vary, but each assignment will have the same weight. Turn in homework on perforated stapled paper **(unstapled homework and homework and/or bits and pieces of paper from a spiral bound note book are unacceptable and will result in points being deducted)**. The purpose of these written problems is to make sure you can clearly write out your thought process for someone to follow, showing all the details of your work and how you arrived at your final answer (you need to do this for quizzes and exams and jobs in the real world). **Do not try and answer all the problems on the homework sheet, use separate sheets of paper** (this will result in a 50% reduction of earned points for that assignment; same goes for the second time this happens, if you do this more than two times, you will simply receive a zero for that homework on the third instance and every following instance).

For all homework problems, draw all sketches, diagrams, and Force Body Diagrams (FBDs) that are needed. In some cases, you may need to add information to provided diagrams. You will likely get potential points for showing diagrams or providing correctly drawn vectors on FBDs for example. **To receive the maximum number of points on homework it is best to follow the mnemonic "E-CAN-SU". ECANSU stands for Equations, Canceling/zeroing, Algebra, Numbers, Significant figures, and Units. You can remember this as, "Everyone CAN be Successful and Useful."** Therefore, the first thing you do when solving a problem is write out the full starting equation you have been taught for a subject, then you cancel out or draw a line through the terms in the equations that go to zero, then you do any needed algebra to solve for the desired variable, then plug in the numbers, then report the answer to the correct number of significant figures, with the appropriate units. Box your final answer. There is no secret, that is the procedure. See also the document **"How to write-up my physics solutions on homework and exams?"** and **"Example Student Homework Solution"** on Blackboard to get the most points on your written homework and exams. Solutions to Written Homework, Quizzes, and Exams will be posted in Blackboard shortly after they are due or completed (if not posted promptly after class when turned in, email me immediately).

Keep in mind that acing the homework with a 100%, though homework is a significant portion of your grade (15% of the total grade) this will not be enough to allow you to pass the class if you do poorly on quizzes and exams; thus, it is not beneficial to copy the homework each week from your peers or unauthorized sources without understanding it. Independent of whether you work in groups on your homework outside of class or work individually and never collaborate with your fellow classmates, **your performance and your performance alone is the determining factor that will allow you to pass course (exams total 63% of the overall class grade and individual quizzes total another 7.5 % of the overall class grade)**. I expect everyone to put the time and effort in on the homework and to try to do very well on it, what will separate out the A, B, C, D, F, and W students will be individual exam/quiz performance. It is ill advised to continually ask your peers for help on the homework and group quizzes and then simply copy what they say without understanding the concepts or the detailed math behind the problem; you might get some partial credit on the written homework and group quizzes, but this is a surefire way to fail the individual quizzes and exams (**70.5% of your total grade is based solely on your knowledge**). If you do not understand the concepts and math, continually ask questions to me or your peers until you understand the concepts and the math, this is how to pass the course.

Quizzes: 20-30-minute quizzes will either be given first thing or at the end of class every Wednesday on non-exam days (TBD). So, there is either a quiz or an exam every Wednesday. Ideally these will be first thing at the start of class, but depends on several factors. There will be two types of quizzes: (1) Individual and (2) Group-oriented quizzes. **The first quiz, on the third day of the semester, will be an individual quiz and it will be on this syllabus (so study this document).** These individual quizzes will be closed-book, closed-note, very quiet, and the equation sheet will be provided. The group-oriented quizzes will allow you the option to work together within a small group of three to four students, but all students must turn in their own quiz (answers can be different), you are not allowed to use any resources for the group quizzes, but are allowed to converse with each other (equation sheets will also be provided, cell phone use is prohibited, using other resources or a cell phone will earn everyone in the group a zero). You are encouraged to discuss and work together to solve the group quizzes. These group quizzes should be a very noisy time with lots of physics being discussed between you and your peers. Ask permission to work with people first, as some students may still choose to work alone. All quizzes are designed to test your understanding of the previous week's homework problems and concepts discussed in lecture the previous week (see schedule at the end of this syllabus). The quizzes may contain a mix of multiple-choice, true & false, require some small written work/calculations, or to do a homework like problem in full detail, showing all steps. Be prepared, don't let yourself or your group members down.

Exams: The exams are individual, closed-book, closed-note, and an equation sheet will be provided. All graded materials require the name that matches your course enrollment in Blackboard, no nicknames. There are 4 in-class exams during the semester, plus a Saturday final common exam on April 20th from 12- 2 pm (all mandatory). Any exam conflicts need to be brought to my attention at least 2 weeks before each exam (check the tentative schedule at the end of this document **now** for all exam dates, if you have known conflicts, report them early). The final common exam will be 'cumulative'. That being said, a lot of the discussed topics in the class will rely on the previous learned material, thus it is best to treat **all material in this class as cumulative** in the sense that new material on exams can use concepts from the previous material. For example, on the second exam, which focuses on Chapters 5-7, you most certainly will need to remember concepts from exam 1, which covers Chapters 1-4 and a little bit of other chapters, plus any math review. Basically, you can't forget what you learn after each exam. I want you all to do well on the exams, thus I will volunteer myself before each regular exam and the final exam for a non-required review session. Experience has informed me that the best time for an Exam Review session is 2 days before the exam and 2 hours is plenty. Thus, your exam reviews will be the Mondays before your exams in the Science Building room 179 from 11-2 pm. Ideally these will start at 11am with a group of students, I will be in my office until 2pm on review days for any students that have to come late. These reviews are your time to ask questions, not for me to re-lecture; if no one has questions, reviews will be most likely be very short, come with specific or general questions. Exams will typically contain a mix of longer written problems (typically 4) similar (but not identical) to homework problems, quiz problems, lecture material, and/or lecture demos, and there will also be some conceptual problems (typically 20). The conceptual questions could be a mix of multiple-choice,

true & false format, fill in the blank, and/or require a small amount of written work/calculations, the longer written problems, will require you to show ALL your work for full and partial credit. **Follow ECANSU for the maximum number of points.** No partial credit is given for the conceptual problems. Written problems will make up 60% of the exam score and the conceptual section will make up 40% of the exam score. **Cell phone use and/or the use any material found, in your area or inside your calculator cover, besides the equation sheet will result in an automatic zero, no questions asked, additional sanctions and/or failure of the class may in sue.**

The Common Final Exam: Your Common Final Exam ***IS*** comprehensive, mandatory, and makes up 15% of your final grade in the course. This is more than one in class exam and equal to your entire homework grade. Your final exam is 12 p.m. to 2:00 p.m. Saturday, April 20th in the Science Building. Room locations will be announced closer to the exam date. **If you miss the final exam, you fail the course.** Previous years have had approximately 30 multiple choice questions, with the questions covering all concepts taught in the class unless otherwise stated, there will be no free response questions. Focus on understanding the basic concepts and doing basic problems with the basic starting equations and basic algebra manipulation. If you study and understand the concepts well, you should do very well on the common final exam. The common final exam is meant to test your basic understanding (algebra will be needed) and is not meant to trick you. If a final exam conflict exists with the scheduled final exam time, follow the steps outlined on the Marshall University Spring 2024 Exam Schedule available at: https://www.marshall.edu/registrar/exam-schedules/. If the two-hour time allowance results in a conflict in exam times, it is the student's responsibility to notify the professor of the later course and to reschedule the later exam. Rescheduled exams must be concluded by Friday, April 26, at 6:00 p.m. Depending on the semester, the 1-week rule may not apply for the final exam simply due to lack of time between when you take the final exam and when final grades are due (so if there are questions on final exam grading, ask them during or before the end of final exam week, grades are due Monday, April 29th 12:00 pm). The Final Exam Review will be in the Science Building, Friday, April 19th, room 179 from 11-2 pm in the normal ''HERD Hours'' time slot.

Emergencies/Unexpectedly Missed an Exam or Quiz or Unable to Turn in Homework: Unexpected emergencies & accidents happen. That is part of life. Fill out the required form: https://www.marshall.edu/student-affairs/excused-absence-form/. Make email contact with me as soon as possible; you must give your reason for missing or, if the reason is too personal, indicate you are applying for a University Excused Absence (UEA) for missing the exam, homework, or quiz in the email. After homework solutions are posted, the same homework assignments cannot be made up, the same goes for Quizzes and Exams; this is independent if you have a UEA. If proper documentation is received, an exemption may be provided instead of the zero at the discretion of the professor. If a UEA is provided in advance, it is more likely you could do a make-up assignment instead of the exemption. Ultimately, the decision of allowing a make-up assignment/Exam or exempting an assignment/Exam for a student with a UEA is completely up to the professor. All missed assignments must have a university excused absence and are counted as zeros until one is received. If you experience a traumatic event in the immediate moments before a quiz or exam, this means the 10-15 minutes or so before the quiz or exam (or some event occurs that alters your normal state of mind in any way for a Quiz or Exam), and you are fairly certain you can get a University Excused Absence (UEA), do not take the quiz or exam; instead, file for the UEA (to take the Quiz/Exam before the next scheduled class or for an exemption). An example for this would be witnessing a homicide of any kind, a violent crime, or witnessing a horrifying accident/fatality on your way to class to take the exam, something that could be confirmed, breaking up with a boyfriend or girlfriend etc. does not count). Any exam or quiz taken counts, independent of state of mind when exam was taken and if a UEA is received later.

As it is often hard to ensure the same level of difficulty for make-up exams as original exams, students are strongly encouraged to participate in the original scheduled exam to ensure an as fair as possible experience. Exam make-ups must be retaken before the next scheduled class after the missed exam. Failure to do so could result in a zero without proper documentation (a UEA) received before the next scheduled class. Only, in very rare circumstances is an exemption with a UEA on an exam allowed. Only one Exam exemption with a legitimate UEA is allowed for an emergency situation only; thus, all students must take 3 out of the 4 in class exams to pass the course. More than 1 missed exam with a proper UEA does not allow for proper assessment and assignment of a letter grade in the course for a student, it is recommended that the student withdraw from the class, if past the withdrawal date the student will receive an Incomplete in the course. Make-up exams will contain completely different problems and will not be returned, though they can be reviewed during office/''HERD Hours''. Make up exams will be completed only after the rest of the class completes the exams, not before. If you are quarantined due to covid or some other illness, and the proper documentation is provided for a UEA, you will be allowed to take the exam in a quarantined environment virtually with very strict proctoring conditions imposed following the PHY 211 protocol form the fall 2020 semester, contact me immediately once you know you test positive and have documentation that can be verified. The protocol will be shared with students in need when the situation arises.

A missed exam or quiz, with no prior email/message & no legitimate supporting documentation before or immediately after counts as a zero and cannot be made up (same goes for homework). Makeup exams, with different content, will be given only after the missed event and only in very rare circumstances, which require official legitimate documentation. The Provost, Sr. VP, and/or Dean of Student Affairs determines what is defined as an "excused absence"- a qualified event for missing exams/quizzes and unexpectedly not being able to turn in homework on the provided due date. Examples include: extreme personal emergencies (house fires, serious crimes, and grave emergencies), university-sponsored activities, medical circumstances, death or critical illness of an immediate family member, short-term military obligations, jury duty, subpoenas for court appearance, etc. If an exam, quiz, or homework is missed, and one of the above is the reason, I will need immediate legitimate official documentation to verify the event in order to schedule a make-up exam/assignment, complete the following form: https://www.marshall.edu/student-affairs/excused-absence-form/.

Computer Requirements: Access to Blackboard and a @marshall.edu email are both required. You are expected to check both frequently. I use Blackboard to distribute lecture notes, supplementary material, and class performance information; sign in at www.marshall.edu in the upper right corner using your unique MU username and password. I also seldom send notices to your Marshall e-mail account and I frequently use 'Notifications' in Blackboard. It is highly advisable to set up your notifications in Blackboard to email you and or text you when a notification posts for the course. If you need help setting this up contact the Design Center team (https://www.marshall.edu/design-center/course-help/). All electronic course communication must be through your Marshall email account (not gmail, yahoo, etc.). My advice to all university students is to check your Marshall email at least twice a day. Many amazing opportunities for students and much information is lost in unchecked email inboxes.

Statement Regarding Students Requiring Special Accommodations & Students with Disabilities: For University policies and the procedures for obtaining services, please go to MU Academic Affairs website (http://www.marshall.edu/academic-affairs/policies/) and see information under "Students with Disabilities". In order to receive any academic accommodations, you must meet with the coordinator of the Office of Disability Services (students are required to provide official documentation of the disability). For help with setting up accommodations, contact the Office of Disability Services (ODS) in Prichard Hall 117 (304-696-2467). For more information, access the website for the Office of Disabled Student Services: http://www.marshall.edu/disabled. If no official documentation from the Office of Disabilities Services is given to the instructor, no accommodations can be made by the instructor. Paperwork must come from the Office of Disabilities, not the student. Trying to get the process for accommodations started the week before an exam will likely not work out for you, more time is needed. Again, before any type of accommodations can be given by instructors, the instructor must receive official documentation from the Office of Disabilities Services or the required program; therefore, take care of this **the first week of classes** (this is true for the H.E.L.P Center and the WV Autism Training Center and the Office of Disability Services).

Statement Defining Expectations for Student Conduct: I will expect everyone in all portions of this class, including, but not limited to lecture time, exam times, quiz times, ''HERD Hours'', and office hours to act in a professional and courteous manner. Students are expected to conduct themselves in a manner that creates a productive learning environment for all members of the class. To this end, disruptive, abusive, or offensive behavior directed at anyone involved in the class will not be tolerated, and offenders may be asked to leave the classroom and forfeit any associated grades for that day. Disruptive behavior is any behavior that interferes with the normal conduct of lecture/quizzes/exams/''HERD Hours'' or behavior that inhibits a productive learning environment (this includes sleeping in lecture and using any non-approved electronic devices). If you are experiencing, disruptive, abusive, or offensive behavior directed towards you from others in the class (this includes when working together in groups outside of class if desired), please make me aware of the problem as soon as possible. In addition to acting professional and courteous in class, I only respond to emails that are written with professionalism and courtesy.

Prohibited Use – Generative AI is fully prohibited in the course: Students are prohibited from using generative AI for graded materials; violation of this, will be considered a violation of both Marshall's Academic Dishonesty Policy (URL: https://www.marshall.edu/academic-affairs/policies/#academicdishonesty) and the Student Code of Conduct (URL: https://www.marshall.edu/student-conduct/files/Student-Code-of-Conduct-2023.pdf). Any assignment deemed as coming from artificial intelligence, at a minimum, will be given zero points with possible additional sanctions imposed.

Campus Services: There are many Campus Services & Resources that you or someone you know throughout your college career may find useful or desperately need at some point. The above link provides contact information for the Counseling Center (304-696-3111) and Health Services, Services for Students in Financial Need, Tutoring Services, and a wide variety of other services and resources (there are many services within each of these categories - check them out now so you know what is available to students). Chances are a version of this syllabus will always be posted on my Teaching Homepage if you ever need this information, even well after the class is over.

University Policies: By having the privilege of being enrolled in higher education and thus this course, you agree to all the University Policies and Codes listed in the below link. It is the student's responsibility to read the full text of each policy and code by going to http://www.marshall.edu/academic-affairs/policies/. The individual policies and codes are: Academic Dishonesty Policy, Academic Dismissal Policy, Academic Forgiveness Policy, Academic Probation and Suspension Policy, Affirmative Action Policy, Pre-Finals Week Policy, D/F Repeat Rule, Excused Absences, Inclement Weather Policy, Sexual Harassment Policy, Students with Disabilities, University Computing Services Acceptable Use Policy, and the Code of Student Rights and Responsibilities - also referred to as the Student Code of Conduct (https://www.marshall.edu/student-conduct/files/Student-Code-of-Conduct-2023.pdf).

Authorized vs Unauthorized Aid in Academic Work: In this course, you are permitted to talk with other students about your written homework problems and even encouraged to work together in groups on the homework during ''HERD Hours'', but you may not copy solutions verbatim from each other or answers verbatim from any other source. You must work the problems out for yourself and understand them. **Remember, 70.5 % of your final grade is based on how you, and only you, can answer questions on the individual exams and quizzes (Exams, 63% and individual quizzes, 7.5 %).** Copying something and not understanding it does you no good now or later. If you have any questions about what constitutes authorized vs. unauthorized aid, contact me immediately. If you copied all your homework and understood nothing, but ace the homework with 100%, congratulations, you have a 15 % as your total grade, certainly an 'F'. Understanding the homework and the quizzes are the single most valuable items for passing this course, they help you pass the bigger items such as exams.

Technology Assistance:
If you have technical problems, please contact one or more of the following:

- Blackboard Student Guide (https://www.marshall.edu/design-center/files/2020/03/Student-Guide-Bb-at-Marshall.pdf)
- Marshall Information Technology (IT) Service Desk (Help Desk) (http://www.marshall.edu/it/departments/it-service-desk/)
  - Huntington: (304) 696-3200
  - Email the IT Service Desk (itservicedesk@marshall.edu) or start a chat with a staff member in the browser. The chat will be saved and emailed to you for your records.

Technical Skill Requirements: For computer and browser requirements for Blackboard, see IT: Recommended Hardware (http://www.marshall.edu/it/recommendations/).

- To check your browsers, use the Blackboard Browser Checker and ensure that you set permissions properly and have all the necessary plug-ins:
- https://help.blackboard.com/Learn/Administrator/Hosting/Release_Notes/Browser_Support/Browser_Checker
- Students must be able to use Marshall email and check it regularly, as well as the basic tools in Blackboard, including the Notification option. Links to Blackboard Help and tutorials are available on the Start Here page and on the Tech Support tab in Blackboard. Blackboard recommends Google Chrome browser or Mozilla Firefox browser.
- The Microsoft Office suite (Office 365) is available is available at no extra charge to students enrolled at MU. For information visit Marshall IT: Office 365 (http://www.marshall.edu/it/office365/).
- See the Tech Support tab in Blackboard for additional information on browsers, technology, and apps.

This current syllabus is based on available information available several days prior to the start of the Spring 2024 semester. If at any time, policies, or a large amount of due dates change, due to covid or for any other reason, an addendum to this syllabus will be provided informing you of what those changes are and the new due dates. The most up to date syllabus will be posted in the syllabus repository when available: https://mubert.marshall.edu/syllabi/.

W	Day	L #	Date	PHY 211 - Subjects	Chapter - (Sections) Required Reading
1	M	1	January, 8	Introduction to PHY 211 and Physics, Syllabus Overview, ESAT (Drop/Add Week)	-
	W	2	January, 10	Chapter 1 - Units and Physical Quantities, Unit Conversions (Quiz 1) (Drop/Add Week)	Ch.1 - (1-4)
				Chapter 1 - Vector Math - addition and subtraction (Drop/Add Week)	Ch.1 - (5-7)
	F	3	January, 12	Chapter 1 - Vector Components, Geometry, Vector Dot and Cross Products (Drop/Add Week)	Ch.1 - (8-10)
2	M	-	January, 15	Martin Luther King Day (University Closed - No Classes)	
	W	4	January, 17	Chapter 1 - Finish Vector Math, Math Review (W1 Due)	Ch.1 - (1-10)
				Chapter 1 - Logs, Distance Formula, Derivatives and Integrals (Quiz 2)	Ch.1 - (1-10)
	F	5	January, 19	Chapter 2 - 1D Motion, Distance Vs. Displacement, Speed Vs. Velocity, Average Vs Instant. Speed	Ch.2 - (1-3)
3	M	6	January, 22	Chapter 2 -Average Vs Instant. Acceleration, Integration and Derivates with x, v, and a (W2 Due)	Ch.2 (3-6)
	W	7	January, 24	Chapter 2 - Integration with BCs, Finding Integration Consatants (Quiz 3)	Ch.2 - (6)
				Chapter 3 - Deriving the Kinematics Equations for Constant Acceleration	Ch.2 - (6)
	F	8	January, 26	Chapter 3 - Projectile Motion	Ch.3 - (1-3)
4	M	9	January, 29	Chapter 4 - Examples of Free Fall, 1D Kinematics, Introduce Newton's Laws (W3 Due)	Ch.4 - (1-6)
	W	10	January, 31	Chapter 11 -Torque, Pulley Problems, FBDs (Quiz 4)	Ch.4 - (1-6), Ch.10- (1)
				Chapter 11 - Pulleys, Conditions for Equilibrium, Newton's 3 Laws - The Three Step Process	Ch.4 - (1-6), Ch.11- (1,3)
	F	11	February, 2	Chapter 5 - Finding the Magnitude and Direction of Reaction Forces at Pivot/Hinged Joints	Ch.5 -(1), Ch.11- (1,3)
5	M	12	February, 5	Chapter 5 - Static Equilibirum and Constant velocity Problems (W4 Due)	Ch.5 -(1), Ch.11- (1,3)
	W		Wed, Feb. 7th	Exam 1 - 10:00-11:50am	Chap. [1, 2, 3, 4, 5.1, 10.1, 11.1, 11.3]
	F	13	February, 9	Chapter 5 - Linked Bodies in Motion and Friction Forces	Ch.5 - (2-3)
6	M	14	February, 12	Chapter 5 - F=ma Problems Where 'a' is Not Zero (W5 Due)	Ch.5 - (2-3)
	W	15	February, 14	Chapter N/A - Area of Stability (Quiz 5)	Lecture Notes
				Chapter 11 - Classic Torque Problems with Friction	Ch.11- (1,3)
	F	16	February, 16	Chapter 3 and 5 - Circular Motion with Forces and Centripetal Acceleration	Ch.3 - (4), Ch.5 -(4)
7	M	17	February, 19	Chapter 3 - Relative Velocity (W6 Due & Midterm Grades Due)	Ch. 3 -(5)
	W	18	February, 21	Ch.6 - Work Energy Theorem (Quiz 6)	Ch.6 - (1-2)
				Chapter 6 and 7 - Gravitational Potential Energy and Power	Ch.6 - (4), Ch.7 - (1)
	F	19	February, 23	Chapter 7 -Work Non-conservation as Internal Energy, Combining Theories to Solve Problems	Ch.7 - (3)
8	M	20	February, 26	Chapter 7 - Work Energy Theorem with Springs (W7 Due)	Ch.6 - (3), Ch.7 - (2)
	W		Wed, February 28th	Exam 2 - 10:00-11:50am	Chap. [1, 2, 3, 4, 5.1, 10.1, 11.1, 11.3]
	F	21	March, 1	Chapter 8 - Momentum, Conservation of Momentum, and Impulse	Ch.8 - (1-4)
9	M	22	March, 4	Chapter 8 - The Ballastic Pendulum (W8 Due)	Ch.8 - (1-4)
	W	23	March, 6	Chapter 7 and 8 - Simple Rocket Propulsion, Relationships between Force & Energy, Energy Diagrams	Ch.7 - (4-5), Ch.8 - (1-5)
				Chapter 9 and 11 - Center of Mass, Intro to Angular Kinematics (Quiz 7)	Ch.11 - (2) Ch.9 - (1)
	F	24	March, 8	Chapter 9 and 10 - Angular Kinematics, Rotational Motion, Conservation of Ang. Mom.	Ch.9 - (1-5), Ch.10 - (1-6)
10	M	25	March, 11	Chapter 10 - Newton's Second Law for Rotational Motion (W9 Due)	Ch.10 - (1-6)
	W	26	March, 13	Chapter 10 - Rotational Motion Examples and Parallel Axis Theorem (Quiz 8)	Ch.10 - (1-6)
				Chapter 10 - Examples of Conservation of Angular Momentum	Ch.10 - (1-6)
	F	27	March, 15	Chapter 10 - Rolling Without Slipping (Last Day to Drop)	Ch.10 - (1-6)
	M	-	March, 18	Spring Break (University Closed - No Classes)	-
	W	-	March, 20		-
	F	-	March, 22		-
11	M	28	March, 25	Chapter 14 - Simple Harmonic Motion, Periodic Motion, Oscillations (W10 Due)	Ch. 14 - (1-6)
	W		Wed, March 27th	Exam 3 - 10:00-11:50am	Chap. [6.3, 7.2,4-5, 8.1-8.5, 9.1-5, 10.1-6]
	F	29	March, 29	Chapter 14 - Examples of SHO - Spring Mass, Simple and Physical Pendulums, Torsional Oscillators	Ch.14 - (1-6)
12	M	30	April, 1	Chapter 15 -Mechanical Waves - Transverse and Longitudinal (W11 Due)	Ch. 15 - (1-6)
	W	31	April, 3	Chapter 15 -Standing Waves, Waves on a String (Quiz 9)	Ch.15 - (7-8)
				Chapter 16 - Interference, Sound Intensities	Ch.16 - (1-9)
	F	32	April, 5	Chapter 16 - Sound Waves in Open-Open and Open-Closed Pipes, interference, Beat f, Shock Waves	Ch.16 - (1-9)
13	M	33	April, 8	Chapter 11 and 16 - Doppler Effect Stress, Strain, Elastic Moduli (W12 Due)	Ch. 11 -(4,5), Ch.16 - (8)
	W	34	April, 10	Chapter 16 and 17 - Pressure Profile in a Tube, Thermal Expansion (Quiz 10)	Ch.16 - (1), Ch.17 - (4)
				Chapter 13 and 17 - Universal Gravitation and Thermal Expansion	Ch.13 - (1-2), Ch.17 - (4)
	F	35	April, 12	Chapter 12 - Pascal's First and Second Laws, Continuity Equation, Bernoillis's Equation	Ch.12 - (1-5)
14	M	36	April, 15	Chapter 12 - Absolute prtessure, gauge Pressure, Bouyancy, Fluid Examples (W13 Due)	Ch.12 - (1-5)
	W		Wed, April 17th	Exam 4- 10:00-11:50am	Chps. [11.4-5, Ch.12 - (1-5) 13.1-2, 14.1-6, 15, 16]
	F	37	April, 19	Discussion to Improve the Course/ESAT	-
Sat.			Saturday, April 20th	PHY 211 Final Common Exam 12-2 pm	All Chapters As Metioned on Exams

Version 1.0
1/5/2024

This is a tentative schedule and syllabus; guidelines, rules, policies, and due dates can be subject to change at any time throughout the semester. We will try to stick as close to the policies and schedule presented here. The most up to date schedule with up to date policies and topics can be found on MU Online. An addendum will be provided with any major changes if needed.

Quiz #	Date	PHY 211 - Subjects
1	January, 10	Anything from the Syllabus is fair game.
2	January, 17	Quiz: Up to and including L3
3	January, 24	Quiz: Up to and including Written Homework 2 and L5
4	January, 31	Quiz: Up to and including Written Homework 3 and L8
5	February, 14	Quiz: Up to and including Written Homework 5 and L13
6	February, 21	Quiz: Up to and including Written Homework 6 and L16
7	March, 6	Quiz: Up to and including Written Homework 8 and L21
8	March, 13	Quiz: Up to and including Written Homework 9 and L24
9	April, 3	Quiz: Up to and including Written Homework 11 and L29
8	April, 10	Quiz: Up to and including Written Homework 12 and L32

Final 211 Topics - 14 Week Semester - Possible Topics to Appear on Common Final Exam

1. Motion in 1 and 2 dimensions
    a. Motion diagrams
    b. Motion graphs (x-t, v-t, a-t)
    c. Determining average and Instantaneous values of velocity and acceleration from graphs
    d. Kinematic equations
    e. Free fall
    f. Vector addition and subtraction
    g. Relative velocity (limited to 1D for relative velocity)
    h. Projectile motion
    i. Uniform circular motion

2. Forces
    a. Newton's Laws
    b. Free-body diagrams, action-reaction pairs
    c. Mass vs. weight
    d. Equilibrium problems
    e. Friction
    f. Motion on an incline
    g. Systems with 2 objects (Atwood)
    h. Hooke's law
    i. Forces on objects in circular motion
    j. Law of gravitation

3. Work and Energy
    a. Definition of work
    b. Net work and kinetic energy
    c. Gravitational and elastic potential energy
    d. Conservation of mechanical energy
    e. Nonconservative systems
    f. Power

4. Momentum
    a. Momentum and impulse
    b. Conservation of momentum, isolated systems
    c. Elastic, inelastic, and totally inelastic collisions
    d. Center of mass

5. Rigid Body Rotation
    a. Angular kinematics
    b. Rigid bodies and center of gravity
    c. Moment of Inertia
    d. Torque
    e. Newton's 2nd law for rotational motion
    f. Static equilibrium

g. Angular momentum and angular kinetic energy
h. Conservation of angular momentum
i. Parallel axis theorem

6. Oscillations
   a. Mathematical description of SHO, motion graphs (x, v, and a as a function of time)
   b. Spring oscillations, period and energy
   c. Simple pendulum
   d. Physical pendulum

7. Waves
   a. Standing waves
   b. Mathematical description of a transverse wave in 1 dimension, snapshots
   c. Waves on a string
   d. Interference of waves in 1 dimension
   e. Standing waves on a string
   f. Doppler effect

8. Sound Waves
   a. Speed of sound, audible frequencies
   b. Sound Interference
   c. Standing sound waves
   d. Intensity level and ranges of a sound, decibel scale

9. Fluid Mechanics
   a. Volume and density
   b. Pressure
   c. Hydrostatic pressure, Pascal's principle
   d. Buoyancy, Archimedes' principle, floating objects
   e. Fluids in motion, continuity equation
   f. Bernoulli's principle

10. Non-Rigid Objects

   a. Bulk Modulus
   b. Shear Modulus
   c. Young's Modulus
   d. Linear Expansion as a result of temperature changes