SANTA MONICA COMMUNITY COLLEGE DISTRICT
Faculty Evaluation Summary Form For Probationary Faculty
Year Two

NAME: Kevin Roberts	DEPARTMENT: Physical Sciences

Overall Rating		Recommendation	
●	Satisfactory	○	Not Enter Into A Contract For The Following Academic Year
○	Needs Improvement	●	Enter Into A Contract For The Following Two Academic Years
○	Unsatisfactory	○	Employ The Probationary Employee As A Regular (Tenured) Employee For All Subsequent Academic Years

Signature	Date
Dept. Peer: Emin Menachekanian Emin Menachekanian (Dec 15, 2023 14:18 PST)	Dec 15, 2023
Non-Dept. Peer: KEITH OUELLETTE (Dec 15, 2023 14:16 PST)	Dec 15, 2023
Dept. Chair. , faculty leader, or designee: Jennifer Hsieh Jennifer Hsieh (Dec 15, 2023 13:20 PST)	Dec 15, 2023
Senior Administrator or designee: LYDIA AYALA (Dec 15, 2023 13:44 PST)	Dec 15, 2023
Evaluatee: Kevin H Roberts	Dec 15, 2023

Faculty member's signature does not necessarily imply agreement. It is merely an acknowledgement that the complete report has been read and a copy received.
Comments: (optional)

Commendations & Recommendations

Kevin Roberts | Fall 2023

Overall, the committee loves Kevin's passion for teaching and the authentic care he shows to his students. Kevin knows every student by name, remembers questions that they asked in previous lecture sessions, and the students are very comfortable approaching Kevin with questions.

The committee has seen progress in Kevin's effort to be more clear about expectations or changes in course policy, as compared to last year. We observed that Kevin has made progress in staying connected with the students, however, he still spends a good deal of time with his back to the students. We also observed that Kevin still struggles with time management. During multiple visits, committee members noted that Kevin's classes ran over time and multiple lab sessions were squeezed into the last hour or less of class, resulting in students rushing.

Jenn and Emin have committed to working with Kevin on class organization and time management. Jenn will meet with Kevin over the Winter intersession to help Kevin plan strategies to stay on pace and ensure that a reasonable agenda is planned for each class meeting. Emin will meet with Kevin to discuss physics topics to help Kevin figure out how the classroom time should be allocated on the major topics of the class. Our hope is this level of intrusive mentorship will help Kevin create tools that will support a classroom environment that isn't rushed. Emin and Jenn have committed to visiting Kevin's classroom in the Spring, informally to provide additional feedback. Lydia, if time permits, will visit Kevin's class in the Spring to see if the additional mentorship has helped Kevin make progress on managing classroom time.

Overall, we're so happy Kevin is at SMC and grateful for the enthusiasm he brings to Physics. We look forward to witnessing his journey from good to great.

Kevin Roberts 2nd Year Evaluation

My evaluation of Kevin Roberts took place on November 15th, 2023. I was able to attend Kevin's Physics 21 course, where my observation took place from 12:15-2:15pm. I joined class about 1 hour after its official start so class was well attended with about a total of 15 students in attendance that day. The class consisted of 3 females and 12 males which was an interesting observation I made based on the discipline Kevin was teaching.

When I waked into class, Kevin had his first break. Kevin did a great job once the class reconvened explaining what the next few weeks in the class would look like. He explained to the students that chapters that were going to be covered and also opened up for questions. A few students asked clarifying questions and Kevin was open and answered all of their questions.

Kevin then decided to move on from chapter 9 and into chapter 10. The central concept that the class was focused on was torque. Kevin's main focus was explaining the relationship of force and distance. He showed this relationship by using examples, mainly diagrams to help the students understand. He proceeded to draw and explain several drawings to the students. At some point, a few students started to get a bit confused. One student did ask for a definition and Kevin did an excellent job of writing out the complete definition on the board and also was explaining the concept of the definition while he was completing the definition on the board. Students still didn't understand but Kevin was able to correct the definition with the addition of a few clarifying words to help the students. I thought this was an important part of the class because instead of Kevin getting frustrated or annoyed at the students, he immediately looked at the definition and recognized the problem and fixed it. There were a lot of drawings that did take Kevin a while to draw and re-draw for each different concept he was explaining. Perhaps providing the students with a hand-out or another visual tool that could be made prior to class could save time. The visual drawing helped and Kevin did a great job of pausing and asking for question pretty frequently.

Kevin then moved into 10.2 which was the focus for the lab portion of the class. Kevin explained the lab to the students before allowing them to work on the lab. Most of all the stuff was easily accessible for the students. He helped explain some of the tricky parts of the equipment and challenged the students for feedback on how they would address those issues. He entered all the students who were present and randomly assigned the lab groups, which I thought, was a fair and fun way to make sure students are working together in various group setting throughout the semester. Kevin proceeded to walk around and help students during the lab. He was interactive with the students and students were responsive to him.

Overall, Kevin has taken sometime over the past year to reflect on how to manage his syllabus and make sure the content of his course is correct. Kevin has always been inclusive in his discussions in class and pauses periodically to ask to see if there are any questions. I still observe that Kevin using a lot of time to draw and write on the white board to provide essential examples for his students. Although I believe this is essential, I would hope there could be a more efficient way for this to be done prior to class or in another manner. I believe this would free up more time for Kevin to engage or allow the students to work on the examples then he could provide feedback. The students seemed very comfortable with Kevin and I think this is essential to a learning environment.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Fall 2023

Department: Physics

Evaluator: Lydia Ayala Position: Assistant Athletic Director

Knowledge, Skill and Ability as an Instructional Faculty Member	Satisfactory or Better	Needs Improvement	Unsatisfactory	Not Observed (NO) Not Applicable (NA)
1. Establishes a student-instructor relationship conducive to learning	●	○	○	○
Comments:				
2. Communicates ideas clearly and effectively	○	●	○	○
Comments:				
3. Stimulates students' interest and desire to learn	●	○	○	○
Comments:				
4. Promotes active involvement of students in learning activities	●	○	○	○
Comments:				
5. Demonstrates sensitivity in working with students from diverse backgrounds and with different needs	●	○	○	○
Comments:				
6. Employs appropriate pedagogy	●	○	○	○
Comments:				
7. Begins class promptly and ends at time designated on schedule of classes	●	○	○	○
Comments:				
8. Uses class time efficiently	●	○	○	○
Comments:				

9. Maintains an appropriate pace during class session	◉	○	○	○
Comments:				
10. Provides students with a syllabus which includes a written explanation of the evaluation process, expectations and requirements, assignments, course content, relevant dates, and other information	◉	○	○	○
Comments:				
11. Teaches course content that is consistent with the official course outline of record	◉	○	○	○
Comments:				
12. Uses materials pertinent to the course content	◉	○	○	○
Comments:				
13. Teaches at a level that is appropriate to the course content	◉	○	○	○
Comments:				
14. Has appropriate command of the subject matter to be able to respond to students' needs	◉	○	○	○
Comments:				
15. Assesses students' progress regularly	◉	○	○	○
Comments:				
Additional comment: Please see attached				

Date(s) of Visit: November 15th , 2023

Length of visit: 2 hours Course (if applicable): Physics 21

Conference Date: 11/21/23

Evaluator's Signature: [YOLA AYALA, Nov 21, 2023 12:12 PST]

Evaluatee's Signature: Kevin H Robinson

Faculty member's signature does not necessarily imply agreement. It is merely an acknowledgement that the complete report has been read and a copy received.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Fall 2023

Department: Physical Sciences

Evaluator: Emin Menachekanian Position: Professor of Physics

Knowledge, Skill and Ability as an Instructional Faculty Member	Satisfactory or Better	Needs Improvement	Unsatisfactory	Not Observed (NO) Not Applicable (NA)
1. Establishes a student-instructor relationship conducive to learning	●	○	○	○
Comments: I thoroughly enjoy how well the rapport is between Prof. Roberts's students and himself.				
2. Communicates ideas clearly and effectively	●	○	○	○
Comments:				
3. Stimulates students' interest and desire to learn	●	○	○	○
Comments:				
4. Promotes active involvement of students in learning activities	●	○	○	○
Comments:				
5. Demonstrates sensitivity in working with students from diverse backgrounds and with different needs	●	○	○	○
Comments:				
6. Employs appropriate pedagogy	●	○	○	○
Comments:				
7. Begins class promptly and ends at time designated on schedule of classes	○	●	○	○
Comments: This is mostly a gripe about time management at the conclusion of the class, which will be described within the narrative.				
8. Uses class time efficiently	○	●	○	○
Comments: I think there is certainly room for improvement in terms of going over content in a pedagogically sound way, but doing so in a much more efficient manner that stays on point with the task with little cases of extraordinarily lengthened digressions. This will be described further within the narrative.				

9. Maintains an appropriate pace during class session	●	○	○	○
Comments: There wasn't a point where I thought that the pace was too fast. There were times when it was a bit slow, but I feel that the improvement points described in the narrative are not necessarily associated with pace. In other words, the slowness at times can be related to efficiency.				
10. Provides students with a syllabus which includes a written explanation of the evaluation process, expectations and requirements, assignments, course content, relevant dates, and other information	●	○	○	○
Comments:				
11. Teaches course content that is consistent with the official course outline of record	●	○	○	○
Comments:				
12. Uses materials pertinent to the course content	●	○	○	○
Comments:				
13. Teaches at a level that is appropriate to the course content	●	○	○	○
Comments:				
14. Has appropriate command of the subject matter to be able to respond to students' needs	●	○	○	○
Comments: One of my favorite aspects of Prof. Roberts' teaching is how he really tries to connect the course content to various topics (e.g., applications to everyday occurrences, historical information, etc.).				
15. Assesses students' progress regularly	●	○	○	○
Comments:				

Additional comment:
Please see the narrative for further elaboration on the items within this observation form.

Date(s) of Visit: 11/01/2023

Length of visit: 128 minutes Course (if applicable): Physics 23

Conference Date: 11/21/2023

Evaluator's Signature: [signature]

Evaluatee's Signature: Kevin Gatton Roberts

Faculty member's signature does not necessarily imply agreement. It is merely an acknowledgement that the complete report has been read and a copy received.

Narrative on the Observation of Prof. Kevin Roberts

Emin Menachekanian

November 16, 2023

Santa Monica College

Department of Physical Sciences

A single observation took place for Prof. Roberts for his Physics 23 class in Fall 2023 on Wednesday, 11/01/23 in SCI 122 from 8:45 - 10:53 am. At 8:45 am, there were 8 students present, and that number kept increasing until it hit a maximum of 15 students around 9:38 am. Prof. Roberts used a sign-in sheet to account for the students that were present, although there seemed to be no direct filtering of tardy students.

To start off, I think Prof. Roberts' most notable commendation really is his ability to connect with his students and to make them feel "at home." He knows the names of all of his students, he says their names when each of them asks a question or makes a comment, and he even compliments and encourages them as much as he can. More than that, he even has a recollection of which student answered a notable question from several classes before! In this instance, the answer involved the reversibility of a process involving ice melting into liquid water when held at an ambient temperature of 0° C, as well as reversibly (with a bunch of infinitesimal "nudges") being able to form into ice from liquid water with that same ambient temperature maintained. With such a recollection, I think students really do realize how genuinely Prof. Roberts cares for them as an instructor.

Indeed, I feel that what Prof. Roberts does in this regard is fabulous, and I have also seen him on countless occasions maintain the same environment in other settings with his students, such as office hours in the neighboring office to mine, as well as office hours in the faculty workroom. I also appreciate his ability to connect the content to various historical or everyday occurrences. As an example, since the class lecture involved talking about the Internal Combustion Engine (ICE), he was keen to mention some facts about fuel, such as how the use of the term "unleaded" is a bit antiquated in this day and age, as well as why the cost of fuel in the summer in California generally is more expensive on account of additives put in the fuel to make the liquid fuel evaporate less in the summer heat. Granted, some descriptions are digressions, but I still feel that every such opportunity to change up the tone and direction of the lecture is a great way to snap students out of the routine and make them ultimately see the relevance of the content (or tangents to the content) in their everyday lives.

With all this said, I do believe there are points of improvement, mostly involving the efficiency of how the class is run, as well as in terms of time management. Again, the eventual descriptions of these improvement points are not meant to downplay the great job that Prof. Roberts is doing in his consistent journey toward becoming an even better educator. My goal is to simply provide feedback so that Prof. Roberts can achieve that goal—to which all of us strive—in the most effective way possible. Indeed, it's the journey that matters, and my task is to serve as a facilitator within that journey, not as a gatekeeper. To that end, I myself know that even after so many years of teaching, I still feel that I have much to learn. In any case, what follows is meant to provide a bit more detail on some aspects of what was observed on 11/01/23.

The class started with a student asking Prof. Roberts' help with a problem on the homework, which involved determining the average value of a Gaussian speed distribution at a given temperature of some collection of particles. His board-work was nice, but there was a lot of fumbling with the process of working out the solution. The problem hinted the student to make use of the Gamma Function of a whole number,

$$\int_0^\infty x^n e^{-ax} dx = \frac{1}{\alpha^{n+1}} \int_0^\infty z^n e^{-z} dz \equiv \frac{1}{\alpha^{n+1}} \Gamma\left(n+1\right) = \frac{n!}{\alpha^{n+1}}.$$

Part of the issue involved not adapting this result (which one can obtain using a sequence of Integrations by Parts) to account for the nature of a Gaussian involving the square of a variable within the exponent,

$$G\left(x\right) \sim e^{-\mu x^2},$$

while the other issue involved not being able to simplify many of the terms appropriately. In some ways, making these errors might have actually been a good thing, as it really forced the students to pay attention to the derivation to ensure that it was being done error-free.

I think this skill of working out problems on the fly is a difficult one, but I think it was still nice that he was willing to see it through, even though many of the above issues led it to take a bit too much time in the grand scheme of what was to be covered during this lecture session. However, a notable thing that occurred while solving this homework problem that really showcased Prof. Roberts' rapport with his students was when a student raised his hand to ask if Prof. Roberts can move his backpack off of the table so that the board could be more visible to him. Realizing this issue, Prof. Roberts held the backpack, moved it

to the board, and made it cover even more of the work on the board. He then asked, "Is this better?" I thought it was a great use of humor to not only change up the mood, but to also make the students feel more comfortable within the classroom. It definitely put a smile on my face when I saw that, as I probably would have done something similar to make the experience more fun!

After this problem was put to rest, I also appreciated the fact that a student felt comfortable enough to ask about the relevance of such a problem. I thought Prof. Roberts did a great job to help the student see the need to do complicated problems, as it gives them the accurate portrayal of the nontrivial nature of many of the things being studied in thermodynamics and statistical mechanics. Although more such problems might be done in an upper-division setting, it's still a healthy exercise for students to get a taste of content that is still within their means to perform (particularly with the aid of hints), but that showcases the next level of doing physics.

Upon describing the aforementioned example of ice melting into liquid water in reversible and irreversible ways, quite a few students were asking great questions. Not to dwell on all of the questions, I just wanted to note how respectfully and poignantly Prof. Roberts tried answering these subtle questions that were poking and prodding at the idealizations being used to practically describe situations involving thermodynamic reversibility.

Prior to getting into the main topic of this lecture, Prof. Roberts also tried connecting the approach to thermodynamics within his class (i.e., Physics 23) to the approach that many students have already seen within Chemistry 12. He notably discussed that the chemist's approach (apart from being mathematically less rigorous) is to favor certain thermodynamic potentials versus others. For instance, Chemistry 12 will likely operate with enthalpy and Gibbs free energy to analyze various thermodynamic phenomena, mostly because of how the chemical processes are being ascertained in the laboratory setting. For instance, enthalpy is favored when the experiment is done at constant pressure, which, for example, is very relevant when the reaction is done within our ambient atmosphere. In contrast, physicists may prefer to analyze things from the perspective of entropy or internal energy. He emphasized that it's not to say that the thermodynamics between the two courses is different, but it's really the perspectives that are different.

Eventually, Prof. Roberts transitioned into the main topic to be described within this lecture: heat engines and the specific quantification of some important heat-engine cycles. To be frank, Prof. Roberts did a great job setting up the theoretical underpinnings of heat engines, whereby the heat flow from a hot to a cold reservoir can be partly utilized to do useful work. I also liked that he immediately connected heat engines to refrigerators as a process of turning the energy-flow diagram of a heat engine in reverse: allowing a reservoir to cool by doing work to dump heat energy to the atmosphere. I thought making this connection was really well done, especially since he was very keen on drawing a very clear energy-flow diagram to illustrate the basic process. In turn, all of the derivations were also done in a methodical and logical fashion. These derivations involved ultimately working out the general expression for the efficiency of a heat engine, as well as determining this efficiency for very specific heat-engine cycles: the Otto and Diesel cycles.

What I would like to describe in the remainder of this narrative is some of the things upon which Prof. Roberts can improve, based on what was seen during this observation (which lasted the entire lecture period). For one point, I found it awkward the sheer amount of time that Prof. Roberts spent trying to draw diagrams on the board. Some of these were not so bad, such as when he drew PV diagrams (i.e., Pressure-vs-Volume diagrams) of the Otto and Diesel cycles. However, the notable one here was the drawing of the Otto cycle itself, where he drew up five distinct diagrams that illustrated the full, four-stroke process of an Otto cycle within the chamber of a piston. Students who had access to the book were told on what page the diagram was, but because he wanted to show the cycle on the board, he took a very long time trying to draw the cycle. The full drawing of it probably lasted upwards of ten minutes. This begged the question: Why not project it? Based on my experience in the room of this lecture, SCI 122, I am well aware of the issues associated with the projector in that room. Although we've put in work orders and have eventually gotten the projector within that room to be replaced, I suspect the issue is not with the projector, but with the antiquated receiver that interfaces with the projector. So, I completely understand why Prof. Roberts did not use his computer to project the image of the cycle onto the screen, as it likely would not have worked, and all of that time would have been wasted for no good reason. Nevertheless, I felt that with better preparation, this could have been circumvented in a couple of ways:

- Make photocopies of the diagram from reprographics and hand them out to the students to have them follow along.
  - This would alleviate the issue of drawing it on the board and make the process of running through the cycle much more efficient.

- By preparing ahead of time to know what the specific parts of the cycle are by memory, draw a *simplified* diagram for each step in the four-stroke cycle.
  - Although it won't be as detailed as a computer-generated drawing in the book, it will definitely get at the heart of what's going on without having to go into tremendous artistic detail.
  - This can also be supplemented by walking around the room with your laptop to show each student what the cycle entails in a detailed drawing.

Another place where efficiency in the class can be prioritized is to digress less on certain topics. For instance, while the Otto cycle was being worked out, a student asked about two-stroke motors. Being honest in his knowledge of the topic, Prof. Roberts did not want to state things about it without any preparation. As such, he said he would report on this later, which was a great move in handling the situation. When a ten-minute break was taken at 10:17 am, Prof. Roberts took the time to research two-stroke motors with his laptop. To be clear, this was an awesome move by him, as he valued the student's question enough to at least give a response. After gleaning some information during the break and resuming class a little before 10:30 am, he tried providing an answer about what a two-stroke engine is, and how it compares to, and contrasts from, a four-stroke engine (e.g., one that operates on an Otto cycle). Honestly, this was a fabulous way to help feed students' curiosity about this, and it turned out to be a type of engine that is actually quite relevant: it is used in gas-powered tools, motorcycles, among other things.

My only reservation about talking about the two-stroke engine was the length of time he took on describing it: namely, about 12 minutes. I think spending about 3 - 4 minutes would have made more sense, particularly since he was intent on also talking about, and deriving the efficiency formula for, the four-stroke Diesel cycle before the end of the class. With the 12 minutes spent talking about a topic that wasn't necessarily part of the plan for the lecture, Prof. Roberts had only about 8 minutes to work through the Diesel cycle. In this way, I think that the class-time was not used efficiently. So, although I definitely commend Prof. Roberts for being very intent on answering a student's question about two-stroke motors and going out of his way to research it during the break, I think stating a few things in passing would have more than sufficed for an answer, especially since there was more to describe before calling it quits for that day. Of course, he could have also taken some time outside of class (perhaps during office hours, via a post about such motors on Canvas, or via an e-mail or direct message to interested students) to provide more information on the topic.

This leads into my last point about improvement that Prof. Roberts can work on: namely, making sure to not finish class too late. Setting himself up for only about 8 minutes to talk about the Diesel cycle, I think with being better aware of time management, the remaining time should have been used to gloss over key similarities and differences between the Otto and Diesel cycles, only to resume with a full derivation of the Diesel cycle's efficiency in, for example, the next class meeting. However, after comparing and contrasting the Otto and Diesel cycles, at about 10:50 am (which is when the class is officially over), Prof. Roberts was intent on going through the full derivation of the efficiency of the Diesel cycle.

When done right, I would surmise this derivation to take no less than about 10 minutes, especially considering students would likely have questions about the details of how the pieces of the derivation are being put together. Indeed, these pieces rely on students having a good working knowledge of various results that have already been worked out in the past, which involve formulas for adiabatic compressions, adiabatic expansions, constant-pressure expansions, as well as constant-volume reductions in pressure. Although some of these latter pieces are things that were described within the Otto cycle's efficiency derivation (which encompasses some of the similarities with that four-stroke cycle), there are some new things to also consider within this derivation.

In any case, without being aware that he had gone over time by about three minutes, a student raised his hand and told Prof. Roberts that the class was done a few minutes ago. Prof. Roberts was still intent on skipping some steps to write down the final result, but again, I think the awareness of time was just not there. Indeed, I firmly believe that if that student hadn't raised his hand and said what he had said, Prof. Roberts probably would have kept going with all of the details, thus ending class far later than it should have ended. Again, I would not be keen to remark on this if there was a semblance of awareness that the class was going over-time; however, given that a lot of this was a consequence of digressing on notions far too long, and not efficiently going over topics that were on point with the course content, I felt the need to describe it within this narrative.

Just to be clear, my intention in describing these aspects of improvement is meant for the sake of shaping Prof. Roberts into an even better teacher than he already is. Again, my goal is to always encourage my colleagues. I am so fortunate to be among such great company within the physics program, and my sole

intent in this process is to provide feedback with some of the experience I have been grateful enough to have developed over time. None of us are perfect, but what matters is for us to always be intent on opening up channels of discourse in order to symbiotically make the teaching within this program as great as it can possibly be for our students. As such, just know that I'm always willing to listen, share thoughts, and ultimately help in any way that I can. That being said, thank you for taking the time to read through this.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Fall 2023

Department: Physics

Evaluator: Keith Ouellette Position: Associate Professor

Knowledge, Skill and Ability as an Instructional Faculty Member	Satisfactory or Better	Needs Improvement	Unsatisfactory	Not Observed (NO) Not Applicable (NA)
1. Establishes a student-instructor relationship conducive to learning	●	○	○	○
Comments: Knows all of his students' names. Students appear comfortable asking questions and volunteering answers in class.				
2. Communicates ideas clearly and effectively	○	●	○	○
Comments: Certain choices for values in a solution presented by the instructor in class were confusing/not clear. Inconsistencies in the setup and solutions to the same problem obtained from class and from online homework.				
3. Stimulates students' interest and desire to learn	●	○	○	○
Comments:				
4. Promotes active involvement of students in learning activities	●	○	○	○
Comments:				
5. Demonstrates sensitivity in working with students from diverse backgrounds and with different needs	●	○	○	○
Comments:				
6. Employs appropriate pedagogy	●	○	○	○
Comments: Provides a balanced mix of introduction, theorems, proofs, examples, and exercises in class discussion.				
7. Begins class promptly and ends at time designated on schedule of classes	●	○	○	○
Comments:				
8. Uses class time efficiently	○	●	○	○
Comments: Insufficient time for students to complete the lab. Time could be saved in class by working out solutions to exercises before class.				

9. Maintains an appropriate pace during class session	●	○	○	○
Comments: Gives students enough time to process ideas, work on examples, and respond to questions.				
10. Provides students with a syllabus which includes a written explanation of the evaluation process, expectations and requirements, assignments, course content, relevant dates, and other information	●	○	○	○
Comments:				
11. Teaches course content that is consistent with the official course outline of record	●	○	○	○
Comments:				
12. Uses materials pertinent to the course content	●	○	○	○
Comments:				
13. Teaches at a level that is appropriate to the course content	●	○	○	○
Comments:				
14. Has appropriate command of the subject matter to be able to respond to students' needs	●	○	○	○
Comments:				
15. Assesses students' progress regularly	●	○	○	○
Comments:				
Additional comment: Please see attached comments.				

Date(s) of Visit: 11/3/2023

Length of visit: 2 hrs Course (if applicable): PHYSICS 21

Conference Date: 11/09/2023

Evaluator's Signature: Keith R. Ouellette

Evaluatee's Signature: Kevin Gatton Roberts

Faculty member's signature does not necessarily imply agreement. It is merely an acknowledgement that the complete report has been read and a copy received.

Peer Evaluation for Kevin Roberts by Keith Ouellette

I visited Prof. Kevin Roberts' Physics 21 Mechanics with Lab class in Science room 106 once on Friday, November 3, 2023 from 12:15pm-2:15pm. Class started on time. I counted 8 students at the start of class. Ten additional students walked in during class at various times.

For the first part of class, Prof. Roberts addressed two student homework questions on Conservation of Momentum in preparation for their exam next week. He always addressed his students by name when they asked him questions.

Prof. Roberts began his solution to a student's homework problem by reviewing the Law of Conservation of Momentum. He clearly drew and labeled free body diagrams illustrating a block sliding down an incline and then colliding with a coiled spring. The goal was to use conservation of energy to find the maximum compression x_{max} of the spring.

In his calculation of the sum of the net external forces in the x-direction, there apparently was some confusion about the sign of x_{max}. One student believed it was positive and another student disagreed, claiming it was negative. After Prof. Roberts went back and forth for some time on this issue, I noticed a growing number students were becoming less engaged in the class discussion. Some students were surfing the Web on their laptops while others were using their phones. One student admitted to being lost. In response, Prof. Roberts provided more detailed calculations. Things were getting clearer for the students paying attention. Prof. Roberts asked if there were any questions. The student who was lost said all of her questions were getting answered. Eventually, Prof. Roberts showed that x_{max} satisfied a quadratic equation. However, it was not immediately clear which of its two solutions was the answer. Prof. Roberts eventually found x_{max} from a careful analysis of the domain of the equation.

Prof. Roberts gave the class a 10-minute break from 1:20pm-1:30pm.

For the second part of class, Prof. Roberts conducted a lab on Conservation of Momentum. After demonstrating the setup for the lab equipment and explaining the experiment, the students began setting up their lab equipment. Prof. Roberts assigned students into groups of 2 or 3 and made sure to visit each group during the lab to answer questions and facilitate the setup. The students appeared to really enjoy the lab. They showed a lot of interest and worked well together. Although, the students were unable to complete the lab since they ran out of time. One suggestion for saving time is to have the students set up their lab equipment concurrently with the instructor as opposed to after.

One student voiced concern in class over the disparities present in the setup of homework problems found in their pre-lecture notes, in their online homework, and in Professor Roberts' presentation. One suggestion for making his class more effective is to have his students email him their homework questions before class. This would enable him to work out the solutions ahead of time and ensure that their setup is more consistent with his other resources.

Overall, Prof. Roberts is a very affable, knowledgeable, and an energetic instructor. I am looking forward to observing his implementation of these suggestions in future classes.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Fall 2023

Department: Physical Sciences

Evaluator: Jennifer Hsieh Position: Department Chair

Knowledge, Skill and Ability as an Instructional Faculty Member	Satisfactory or Better	Needs Improvement	Unsatisfactory	Not Observed (NO) Not Applicable (NA)
1. Establishes a student-instructor relationship conducive to learning	●	○	○	○
Comments:				
2. Communicates ideas clearly and effectively	●	○	○	○
Comments:				
3. Stimulates students' interest and desire to learn	●	○	○	○
Comments: Kevin shares videos and uses engaging problems that make a topic that could be very dry much more interesting and relevant.				
4. Promotes active involvement of students in learning activities	●	○	○	○
Comments: The group work was awesome, please see my comments in the attached narrative.				
5. Demonstrates sensitivity in working with students from diverse backgrounds and with different needs	●	○	○	○
Comments:				
6. Employs appropriate pedagogy	●	○	○	○
Comments:				
7. Begins class promptly and ends at time designated on schedule of classes	○	●	○	○
Comments: On the day of my visit, Kevin allowed the Physics 23 class to run over by 15+ minutes. I had to leave before the lab had wrapped up.				
8. Uses class time efficiently	●	○	○	○
Comments: Kevin uses all the time given and more, see above, but overbudgets how much he can cover in a particlar class session.				

9. Maintains an appropriate pace during class session	○	●	○	○
Comments: The pacing of the class needs to improve. Too much time is spent writing out the text of a long problem on the board, when a worksheet could be provided. Too much time was prioritized on lecture during my Physics 23 visit, leaving the students to rush through their lab and still need to stay late.				
10. Provides students with a syllabus which includes a written explanation of the evaluation process, expectations and requirements, assignments, course content, relevant dates, and other information	●	○	○	○
Comments:				
11. Teaches course content that is consistent with the official course outline of record	●	○	○	○
Comments:				
12. Uses materials pertinent to the course content	●	○	○	○
Comments:				
13. Teaches at a level that is appropriate to the course content	●	○	○	○
Comments:				
14. Has appropriate command of the subject matter to be able to respond to students' needs	●	○	○	○
Comments:				
15. Assesses students' progress regularly	●	○	○	○
Comments: Kevin assigns regular homework, gives three mid-terms and a final. These assessments provide reasonable feedback for students to keep track of their progress throughout the semester.				
Additional comment: Please see additional feedback in the attached observation notes document.				

Date(s) of Visit: Oct 27th, Nov 1

Length of visit: 4 hrs Course (if applicable): Physics 21 and 23

Conference Date: 11.21.23

Evaluator's Signature: [signature]

Evaluatee's Signature: Kevin Gratton Roberts

Faculty member's signature does not necessarily imply agreement. It is merely an acknowledgement that the complete report has been read and a copy received.

Observation Notes

Evaluation of Kevin Roberts

Fall 2023

Physics 23 – October 27, 8:55 am – 12:00 pm

I visited Kevin's Physics 23 class on Friday, Oct 27. My purpose for attending this meeting was to observe Kevin's interactions with the students while they completed a lab. The class is scheduled 8:45 am – 11:45 am. When I arrived, Kevin was showing students how to solve a problem that looks at the relationship between the temperature and volume of a gas in a closed cylinder. Instructional time is mixed use for physics classes, so I assumed that the later half of the class would be dedicated to lab work. Kevin continued to lecture until 9:50 am and then gave students a 10 minute break. At 10 am, he returned to lecturing until just before 11 am. At 11 am, Kevin gave students a 5 minute break before they started the lab. As students were returning, slowly, Kevin rushed through lab set up in about three minutes and then told the students to get started. This left the students about 35 minutes to collect their data and clean up before class should end at 11:45 am. At 11:45 am, no one was done, so I stayed a bit longer to observe. By 11:40 am, the first group cleaned up and left. At noon, I had to leave to teach my own class and the majority of the class was still present. I have in my notes that Kevin told the class you can just stay late, there is a 30 minute break. I don't recall anyone protesting about this, which makes me wonder how often the class runs late.

I think it's important to note that our course content should be covered in the time that is scheduled for the class. It's ok if you run over by a few minutes (3 – 5 minutes) periodically to wrap up an idea, but it is not appropriate to run over by 15+ minutes nor is it appropriate to run late on a consistent basis. What this suggests is that time management is a problem. Lab is an opportunity for students to see physics principles come to life in real-time. It's probably one of the most important components to understanding the theory. It shouldn't be rushed. In the course outline of record, Physics 23 is listed as having a 3 hour in-class lab. Friday labs really should be saved for lab, plus a little extra lecture, if there is time. My recommendation would be to start lab day with a well-paced pre-lab lecture discussing how to setup the equipment, pitfalls to look out for, some discussion about how the post-lab analysis work should be completed and include any relevant lecture theory that will help the students make connections. This will likely take 30 – 40 minutes. After that, allow the students time and space to collect their data without frantically rushing. This creates space for you to help troubleshoot problems when equipment doesn't work. If everyone finishes in an hour, then that gives you about an hour to lecture at the end of class. Importantly, the students should be able to leave class on time. They have other classes as well as work or family obligations. When they registered for the class, the start and end times were accounted for in their schedules.

I noted that some of the lab equipment was not working well. I have already spoken with Kevin about working with the stockroom technician to replace cracked tubing and hand pumps that no longer work well. Kevin was doing his very best to help the students get their data, but he should not have to pump half the hand pumps because they work so poorly. He was so busy troubleshooting that there were groups that struggled for at least 30 minutes to get their set up working correctly. Kudos to Kevin, but let's figure out a way to make the lab a better learning experience.

Kevin relied primarily on board work for delivery of information to the students. His writing is neat and he uses fresh pens so that the writing is fairly clear. I would encourage Kevin to write a little bit larger. While I wear glasses, occasionally I had trouble differentiating letters/numbers that look the same (for example o's/c's). I was sitting on the south side of the room, in the second row of desks. I also noted that Kevin tends to stand directly in front of the board where he is writing, so I heard all of his dictation but I had no idea what the writing looked like until he stepped away. There are two ways to address this issue: (1) would be to write while standing slight off to the side (I can demo when we meet) or (2) would be to write everything, step back, and then dictate/explain what was written.

At one point, Kevin was having students solve some problems that must have been from the textbook. These were paragraph style questions that took considerable time to copy from his laptop to the board. It would be more efficient to plan ahead and copy these questions onto a worksheet that can be shared electronically, as a printout, or both, so that the students have access to the questions and do not need to spend considerable time copying the questions down.

I found the flow of topics to be a little confusing. When I arrived, it looked like Kevin was wrapping up a chapter, probably chapter 19, and then he started chapter 20. This made sense. Then around 9:30 am, he switched to talking about heat engines. At first, I thought that the heat engine discussion was related to the upcoming lab, but it wasn't. It did not seem connected to his earlier chapter 20 discussion either. So, I am unclear why we abruptly started talking about heat engines, except that the following week's lab would explore heat engines (I think?).

Kevin knew all the students' names. The students were very comfortable asking questions and they asked really good questions too. At around 10 am, Kevin assigned students to groups of 3 and asked them to work on three textbook questions that were projected on the screen. The text was small, and students took photos so they could have access to the text close by. Again, I would suggest creating handouts that you can use for this semester and future semesters. Once you get a good problem set, you can use them for a very long time. I loved how the students worked collaboratively on the problems. The idea of requiring that each student take a turn to write the answer seemed to encourage students to work together. I noticed that one group tried to split up the work and not collaborate, but Kevin engaged with them respectfully and they started working together. This activity took considerable time and could have been a nice way to finish the day after lab. It's also an easy activity to transition to when groups finish at different times.

All in all, I loved Kevin's passion for the material, the way he engages with the students, and the sense of safety that the students have as demonstrated by how comfortable they were with asking questions or for help.

Physics 21 visit – November 1, 1:00 pm – 2:00 pm

I visited Kevin's Physics 21 class to see how he interacts with students that have less experience with physics, as Physics 21 is the first class in the sequence. When I arrived, Kevin was showing a video and eating his lunch at the front bench. The class is scheduled for 11:15 am – 2:15 pm and his Physics 23 class ends at 10:50 am. I understand it is scheduled during normal lunch hours and he has another class earlier in the morning, but when this happens, instructors usually eat a snack between classes, followed

by a late lunch. It's not professional to eat during class and presently it's against building policy to eat in the classrooms. While I plan to bring the food and drink policy back to the department for discussion soon, currently the policy is that only water may be consumed in the classroom, if the water is stored in a sealable container.

The video was interesting. It showed a demo where students could visualize radioactive decay that occurs around us, all the time. It's possible that video was connected to the lecture material that I missed in the first hour, but it did not seem to connect with the 1 – 2 pm discussion. The 1 – 2 pm discussion focused on understanding center of mass.

In this meeting I sat at the other side of the classroom, and while I could see the board when Kevin's back was to the students, I had a difficult time reading the writing due to the size of the writing and the angle that I was sitting at. I noticed that students sitting in the back of the room, at the lab benches, were not really paying attention. They had their laptops out and it appeared that they were working on other assignments. There were three people that asked questions consistently, they all sat in the front row. Eventually, Kevin used the popcorn technique to engage more students beyond the three. This was great and I noticed that students in the back started to pay more attention once the popcorn started.

Toward the end of lecture, Kevin presented a problem where two people were playing tug of war on ice. Later in the conversation, Kevin pulled up a simulation that made the concept so much easier to understand. I would recommend starting this practice problem and this discussion using the simulation to give students something tangible to understand before diving deep into the variable heavy equations.

I noticed toward the end of lecture, Kevin told the students there wasn't enough time for lab today, so he would push it to Friday. This reminds me again of issues with time management. I don't know the expectation of preparation for a physics lab, but in chemistry we expect students to prepare for their lab and we also require them to bring personal protective equipment to use during the lab. I imagine that it can be frustrating for students to plan on doing something (lab), only to find out that it has been postponed. My personal feeling is that certain activities (exams, quizzes, and labs), should have non-negotiable dates. A lot of times students plan their days around these types of activities, so we should honor their time and stick to those scheduled activities unless there is an unforeseen circumstance that prevents them from happening. Examples that I have experienced include times when I got so sick that I cannot leave the house to administer an exam (we can often get a last-minute sub for exams, please ask) or a fire in the Sepulveda pass that makes it impossible for me to get to campus.

Notes on the syllabus

Below, I will suggest changes that you should consider making to your syllabus. You can use the language given or update it to reflect your voice. I only reviewed the Physics 23 syllabus, but please make sure your other syllabi are consistent.

1. Mastering Physics – do you make an access code for the homework platform available for purchase at the bookstore?
2. A grade of "Incomplete" may be granted at the very end of the term if an unforeseen event or illness prevents you from completing the final coursework and at the time you have earned a "C" or better. "Incomplete" grade situations are extremely rare, and are entirely at the discretion of the instructor, within the parameters set above. – You may not need to include this detail, but be

aware that students need to have completed >= 90% of the course work at the time of the request.

3. You are responsible for maintaining your own enrollment status. You may drop the course with a withdrawal until July 19, 2023 ← likely a typo. It is NOT possible to drop the class <after> that date.
4. The date of the final is Wednesday December 13. Include the time too.
5. The sustainable works website link is broken. I'm curious about the time commitment to the two extra credit opportunities. I think the sustainable works EC requires significantly more time than the distinguished scientist lecture. That said, there is only one lecture per semester. Is there a way to balance these activities so that one is not significantly easier than the other, while only being accessible to students that happen to have time to participate?
6. I *love* the section on rules for homework and in-class work. If/when I go back to teaching lecture, I am going to have to borrow/adapt this from you for my chemistry exams.

Notes on Physics 23 Canvas

The home page looks like you intended to link out to each of the chapters, but those links are not active. When I clicked the link to the getting started module, I see that there is a lot posted in the modules. That said, it looks like there are quite a few resources that are unpublished. I'm not sure if this was intentional, but you might want to double check. There is a function in setting that will check all links and report back what isn't published that might need to be published. Let me know if you need more information about the validator tool.

Conclusion

Overall, I enjoyed observing Kevin's classes. Kevin has a lot of great energy and ideas. The students respect him and interact well with him. That said, I think there is still work to be done with managing classroom time and pacing better. I look forward to watching Kevin's continued growth as an instructor in our department.

PROFESSIONALISM FORM

Evaluation of: Kevin Roberts Semester: Fall 2023

Department: Physical Sciences

Evaluator: Jennifer Hsieh Position: Department Chair

This section to be completed by the department chair / leader or department chair/ leader designee *As input to the evaluation procedure*	Satisfactory or Better	Needs Improvement	Unsatisfactory	Not Observed (NO) Not Applicable (NA)
1. Demonstrates cooperation and sensitivity in working with colleagues and staff	●	○	○	○
Comments:				
2. Responsive to constructive feedback	●	○	○	○
Comments:				
3. Participates at the appropriate level in creation, assessment, and / or discussion of SLOs	●	○	○	○
Comments:				
4. Submits required departmental reports and information on time (Drop roster, grade roster, flex form)	●	○	○	○
Comments:				
5. Maintains adequate and appropriate records	●	○	○	○
Comments:				
6. Observes health and safety regulations	●	○	○	○
Comments: Kevin brought to my attention some safety related issues that Physics is facing. In particular, they have been using kitchen oven mitts that are falling apart to handle hot materials in Physics 23. Unless someone asks to replace these, I wouldn't know about the issue. I appreciate that Kevin brought this and other concerns to my attention.				
7. Per the collective bargaining agreement, maintains office hours and attends required meetings	●	○	○	○
Comments:				

8. Responsive to students and is accessible to students	●	○	○	○
Comments:				
9. Adheres to departmental and college policies	●	○	○	○
Comments: Please remember that current building policy prohibits eating food in the classrooms.				
10. Participates in departmental and campus wide activities	●	○	○	○
Comments: Kevin helped at VIP day and the Science Complex open house. He also serves as advisor to the astronomy club.				
11. Maintains currency in professional knowledge through professional literature, professional memberships, workshops, conferences, or other activities	●	○	○	○
Comments:				

Additional comment: Kevin is a great colleague and he brings a lot of energy and enthusiam to the physics program. Kevin, along with another colleague, have been organizing and updating the Physics stockroom. This is a welcome change as a lot of old equipment had accumulated that was no longer functional and many items need updates or repairs. Additionally, the students seem to love Kevin as an instructor. He routinely draws in large crowds during office hours.

My one concern focuses on Kevin's improvement progress in the classroom. Based on what I read in Kevin's 1st year evaluations, there were concerns about pacing and keeping a schedule for exams/labs. Last year, evaluators noted that some parts of class were rushed and others were given more time than necessary. Additionally, one evaluator dropped in to observe class only to find out that an exam had been moved into that date, last minute. I noted issues with pacing during my Physics 23 visit and during my Physics 21 visit, the students were notified toward the end of class that they would have to postpone lab to another date.

I think we should meet to discuss strategies to improve pacing and scheduling for Spring 2024.

Conference Date: 11.21.23

Evaluator's Signature: [signature]

Evaluatee's Signature: Kevin Gratton Roberts

Faculty member's signature does not necessarily imply agreement. It is merely an acknowledgement that the complete report has been read and a copy received.

Santa Monica College

Course Outline for
PHYSICS 21, Mechanics with Lab

Course Title: Mechanics with Lab — Units: 5.00

Total Instructional Hours (usually 18 per unit):	144.00
Total Student Learning Hours:	270.00
Hours per week (full semester equivalent) in Lecture:	3.50
In-Class Lab:	4.50
Arranged:	0.00
Outside-of-Class Hours	180.00

Date Submitted: March 2022
Date Updated: June 2022
C-ID: PHYS 205
Transferability: Transfers to CSU
Transfers to UC

IGETC Area:

IGETC Area 5: Physical and Biological Sciences (mark all that apply)
- 5A: Physical Science
- 5C: Physical or Biological Science LABORATORY

CSU GE Area:

CSU GE Area B: Scientific Inquiry and Quantitative Reasoning (mark all that apply)
- B1 - Physical Science
- B3 - Laboratory Sciences

SMC GE Area:

GENERAL EDUCATION PATTERN (SMC GE)
- Area I: Natural Science

Degree Applicability: Credit - Degree Applicable
Prerequisite(s): MATH 7
Pre/Corequisite(s): None
Corequisite(s): None
Advisory(s): None

I. Catalog Description

This course is a calculus-based study of the mechanics of rigid bodies, emphasizing Newton's laws and its applications. This course includes an introduction to fluids. It is designed for engineering, physical science, and computer science majors.

II. Examples of Appropriate Text or Other Required Reading: (include all publication dates; for transferable courses at least one text should have been published within the last seven years)

1. University Physics with Modern Physics, 14th , Young & Freedman, Pearson © 2015, ISBN: 9780321973610;
2. Physics for Scientists and Engineers, 10th, Serway & Jewett, Cengage Learning © 2018, ISBN: 9781337553278;
3. Fundamentals of Physics, 11th, Halliday, Resnick, Walker, Wiley © 2018, ISBN: 9781119286240;
4. Santa Monica College Physics Faculty . Online Laboratory Manual for Physics 21, Santa Monica College
5. Mastering Physics, computer-based homework management and tutoring program to accompany text.
6. Heuvelen, Alessandris, Braun, Wozny. Study Guide with ActivPhysics 1, Volume 1.
7. Student Solution Manual to accompany textbook.

III. Course Objectives

Upon completion of this course, the student will be able to:

1. Use the basic concepts in physics to qualitatively explain physical phenomena.
2. Compile data from a physical problem and synthesize these data into a mathematical problem.
3. Take the mathematical problem to a successful conclusion using mathematical principles of algebra, trigonometry, and calculus.
4. Operate, adjust, and use the equipment necessary in laboratory experiments to obtain quantitative measurements.
5. Estimate the uncertainty of a measurement and calculate the uncertainty in the results obtained from such measurements.
6. Use the mathematical tools of the computer, such as spreadsheets and graphing programs, to analyze data.
7. Write laboratory reports including statement of purpose, compilation of data, theory involved in the experiment, method of measurements, samples of calculations, tabulation of results, and analyses of sources of error.
8. Continue their science education by having the skills to succeed in more advanced physics courses.

IV. Methods of Presentation:

Other (Specify), Lab, Lecture and Discussion, Experiments, Group Work, Observation and Demonstration
Other Methods: The methods of presentation used in this class reflect the importance of both a conceptual understanding of physics as well as the analytical mastery of the subject. Lecture and class-demonstrations, including computer simulations and videos, are used to introduce topics to students and to ground those ideas in reality. Most experimental work not only reinforces core concepts but teaches experimental measurement techniques and the errors associated with them. Physics Education Research (PER) has shown that active-engagement instructional strategies greatly improve student learning. As a result, collaborative learning activities are used in lecture and lab as part of the methods of presentation.

V. Course Content

% of Course	Topic
20.000%	Kinematics: Introduction & Vectors, Motion in 1 and 2 Dimensions

25.000%	Dynamics: Force, Motion and Newton's Laws, Circular Motion, Gravitation
25.000%	Conservation Principles: Work, Energy, Power, Conservation of Energy, System of Particles, Conservation of Momentum
25.000%	Rotations and Oscillations: Rotational Dynamics, Angular Momentum, Static Equilibrium, Simple Harmonic Motion
5.000%	Introduction to Fluids
100.000%	Total

Vb. Lab Content:

% of course	**Topic**
8.00%	Measurement and Errors
7.00%	Addition of Vectors
8.00%	Graph Matching and Motion
8.00%	Projectile Motion
8.00%	Circular Motion
8.00%	Newton's Second Law
8.00%	Non-conservative Forces
8.00%	Energy
8.00%	Ballistic Pendulum
8.00%	Rotational Inertia

7.00%	Rigid Equilibrium
7.00%	Physical Pendulum
7.00%	Problem Solving Activities
100.00%	Total

VI. Methods of Evaluation: (Actual point distribution will vary from instructor to instructor but approximate values are shown.)

Percentage	Evaluation Method
55 %	Exams/Tests - 3 or 4 Unit Exams
25 %	Final exam
15 %	Lab Reports - 8 to 12 Laboratory Activities
5 %	Written assignments - Problem Homework Assignments
100 %	Total

VII. Sample Assignments:

See attached files:

See attached files:

VIII. Student Learning Outcomes

1. When presented with a physical situation and asked to solve a particular problem in mechanics (i.e. two masses connected via a string passing over a pulley), the student will follow a logical process based on well-established physics principles (i. e. Newton's laws) and demonstrate ability to use basic mathematical techniques including calculus.
2. When conducting a laboratory experiment and writing a lab report, the student will demonstrate understanding of the basics of the scientific method by being able to state a clear and testable hypothesis, taking careful measurements, estimating uncertainties, and drawing appropriate conclusions based on gathered data and on sound scientific principles.

Santa Monica College

Course Outline for
PHYSICS 23, Fluids, Waves, Thermodynamics, Optics with Lab

Course Title: Fluids, Waves, Thermodynamics, Optics with Lab

Units: 5.00

Total Instructional Hours (usually 18 per unit):	126.00
Total Student Learning Hours:	270.00
Hours per week (full semester equivalent) in Lecture:	4.00
In-Class Lab:	3.00
Arranged:	0.00
Outside-of-Class Hours	144.00

Date Submitted: March 2022
Date Updated: June 2022
C-ID: PHYS 215
Transferability: Transfers to CSU
Transfers to UC

IGETC Area:

IGETC Area 5: Physical and Biological Sciences (mark all that apply)
- 5A: Physical Science
- 5C: Physical or Biological Science LABORATORY

CSU GE Area:

CSU GE Area B: Scientific Inquiry and Quantitative Reasoning (mark all that apply)
- B1 - Physical Science
- B3 - Laboratory Sciences

SMC GE Area:

GENERAL EDUCATION PATTERN (SMC GE)
- Area I: Natural Science

Degree Applicability: Credit - Degree Applicable
Prerequisite(s): PHYSCS 21
and
MATH 8
Pre/Corequisite(s): None
Corequisite(s): None
Advisory(s): None

I. Catalog Description

This course is a calculus-based study of fluids, waves, thermodynamics, and light intended for engineering and physical science students.

II. Examples of Appropriate Text or Other Required Reading: (include all publication dates; for transferable courses at least one text should have been published within the last

seven years)

1. University Physics with Modern Physics, 15th , H. Young & R. Freedman, Pearson © 2019, ISBN: 9780135159552;
2. Physics for Scientists and Engineers, 10th, R. Serway & J. Jewett, Cengage Learning © 2019, ISBN: 9781337553278;
3. Fundamentals of Physics, 10th, D. Halliday, R. Resnick, J. Walker, Wiley © 2013, ISBN: 978-1118230728;
4. Santa Monica College Physics Faculty . Online Laboratory Manual for Physics 23, Santa Monica College
5. Mastering Physics . Pearson, 15th ed.
   Computer-based homework and tutorial problems to accompany the Young and Freedman text.

III. Course Objectives

Upon completion of this course, the student will be able to:

1. Use basic concepts in physics to construct a qualitative explanation of physical phenomena.
2. Use physical principles and laws to construct a quantitative explanation of physical phenomena through mathematical analysis.
3. Utilize various mathematical methods such as algebra, trigonometry and calculus, to navigate through the quantitative analysis of a physical problem.
4. Proficiently operate and adjust laboratory equipment to obtain quantitative measurements in a physics experiment.
5. Estimate the uncertainty of a measurement and the propagation of error for results dependent upon the measurement.
6. Use various computational tools such as spreadsheets and graphing programs to analyze data.
7. Compose organized and thorough analyses of work done in the laboratory.

IV. Methods of Presentation:

Lecture and Discussion, Other (Specify), Group Work, Lab, Experiments
Other Methods: The methods of presentation used in this class reflect the importance of both a conceptual understanding of physics as well as the analytical mastery of the subject. Lecture and class-demonstrations, including computer simulations and videos, are used to introduce topics to students and to ground those ideas in reality. Most experimental work not only reinforces core concepts but teaches experimental measurement techniques and the errors associated with them. Education research has shown that active-engagement instructional strategies greatly improve student learning. As a result, collaborative learning activities are used in lecture and lab as part of the methods of presentation.

V. Course Content

% of Course	Topic
13.000%	Fluid dynamics
24.000%	Mechanical waves: transverse string waves, sound waves

33.000%	Thermodynamics: temperature and 0th law, kinetic theory of classical gases, heat and 1st law, heat transfer, entropy and 2nd law
30.000%	Geometric and wave optics: reflection, refraction, interference, diffraction
100.000%	Total

Vb. Lab Content:

% of course	**Topic**
10.00%	Fluid Mechanics
10.00%	String Waves
10.00%	Longitudinal Waves
10.00%	Thermal Expansion
10.00%	Heat Transfer
10.00%	Latent Heats
10.00%	Ratio of Specific Heats
10.00%	Refraction
10.00%	Mirrors and Lenses
10.00%	Diffraction
100.00%	Total

VI. Methods of Evaluation: (Actual point distribution will vary from instructor to instructor but approximate values are shown.)

Percentage	Evaluation Method

55 %	Exams/Tests - 3-5 Unit Exams
25 %	Final exam
5 %	Homework
15 %	Lab Reports - Laboratory
100 %	Total

Additional Assessment Information:
The unit exams and quizzes are given regularly throughout the semester and will include questions that are of the short-essay type and numerical problems similar to those assigned in class. A comprehensive final exam is given covering the entire semester's work. This three hour exam consists of questions and problems that require the student to apply the knowledge obtained from the course and extend it to new situations.

VII. Sample Assignments:

Sample homework assignment:

1. Weekly homework assignment consisting of 20-30 textbook problems such as:

A soft drink (mostly water) flows in a pipe at a beverage plant with a mass flow rate that would fill 220 0.355-L cans per minute. At point 2 in the pipe, the gauge pressure is 152 kPa and the cross-sectional area is 8.00 cm2. At point 1, 1.35 m above point 2, the cross-sectional area is 2.00 cm2.
a) . Find the mass flow rate.
b) Find the volume flow rate
c) . FInd the speed at point 1
d) . FInd the speed at point 2.

sample lab assignment:

In this laboratory experiment, students apply Archimedes' principle to determine the density of air in the lab room. They also identify an unknown substance using Archimedes' principle.
The sample lab experiment is attached as a file.

VIII. Student Learning Outcomes

1. When presented with a physical situation and asked to solve a particular problem in fluids, thermodynamics, wave phenomena, or optics, the student will follow a logical process based on well-established physics principles (i.e. laws of thermodynamics) and demonstrate ability to use basic mathematical techniques, including calculus.
2. When conducting a laboratory experiment and writing a lab report, the student will demonstrate understanding of the basics of the scientific method by being able to state a clear and testable hypothesis, taking careful measurements, estimating uncertainties, and drawing appropriate conclusions based on gathered data and on sound scientific principles.

PHYSICS 21, MECHANICS WITH LAB

FALL 2023

COURSE INFORMATION

Course Title:	PHYSICS 21, MECHANICS WITH LAB
Section Number:	3023
Units:	5.00 units
Prerequisite(s) or Advisories:	Mathematics 7 with a minimum grade of C or equivalent, trigonometry will be reviewed, but familiarity will be assumed.
Day and Time:	Monday, Wednesday 11:15 AM –2:15 PM
Location:	SCI 106
Day and Time:	Friday 12:15 PM –2:15 PM
Location:	SCI 106

INSTRUCTOR INFORMATION

Instructor:	Kevin Roberts
Email Address:	Roberts_kevin31@smc.edu
Office Hours:	Monday, Wednesday 02:20–4:00 PM in SCI 275 Additional Meetings on Zoom by Appointment (Meeting ID: 809 988 3587, Password: SMCPhys)

I welcome you to contact me outside of class and student hours. You may email me, message me on Canvas or tag me on the class Discord. You may also make office hours by appointment.

COURSE DESCRIPTION

This course is a calculus-based study of the mechanics of rigid bodies, emphasizing Newton's laws and its applications. This course includes an introduction to fluids. It is designed for engineering, physical science, and computer science majors.

COURSE OBJECTIVES

Upon completion of this course, the student will be able to:

1. Use the basic concepts in physics to qualitatively explain physical phenomena.
2. Compile data from a physical problem and synthesize these data into a mathematical problem.
3. Take the mathematical problem to a successful conclusion using mathematical principles of algebra, trigonometry, and calculus.
4. Operate, adjust, and use the equipment necessary in laboratory experiments to obtain quantitative measurements.
5. Estimate the uncertainty of a measurement and calculate the uncertainty in the results obtained from such measurements.
6. Use the mathematical tools of the computer, such as spreadsheets and graphing programs, to analyze data.
7. Write laboratory reports including statement of purpose, compilation of data, theory involved in the experiment, method of measurements, samples of calculations, tabulation of results, and analyses of sources of error.
8. Continue their science education by having the skills to succeed in more advanced physics courses.

STUDENT & INSTITUTIONAL LEARNING OUTCOMES

1. When presented with a physical situation and asked to solve a particular problem in mechanics (e.g., two masses connected via a string passing over a pulley), the student will follow a logical process based on well-established physics principles (i.e., Newton's laws) and demonstrate ability to use basic mathematical techniques including calculus.
2. When conducting a laboratory experiment and writing a lab report, the student will demonstrate understanding of the basics of the scientific method by being able to state a clear and testable hypothesis, taking careful measurements, estimating uncertainties, and drawing appropriate conclusions based on gathered data and on sound scientific principles.

REQUIRED TEXTS, MATERIALS, & SUPPLIES

1. Young, Freedman, and Ford, University Physics with Modern Physics. 15th ed. WITH MASTERING PHYSICS REQUIRED You can get either the digital or hard cover versions if you have an unused Mastering code. We will be using it for online homework.
2. Scientific or graphing calculator. You may use Desmos or Wolfram Alpha.
3. Computer and Internet access.
4. Installed desktop Microsoft office. (Free via SMC)
5. Notebook and writing implement(s) (digital tablets are an acceptable option)

RECOMMENDED RESOURCES & SKILLS

Supplementary Texts

1. Adelson, Get ready for physics
2. McMullen, Essential Calculus-based Physics Study Guide Workbook: Laws of Motion, Volume 1

Computer Skills

To succeed in this course, you should have the ability to:

- Navigate the Internet using a web browser.
- Manage files using either the Mac or Windows operating systems.
- Send and receive email messages and attachments.
- Use a word processing program like Microsoft Word or its equivalent.
- Navigating Canvas: checking assignment deadlines, uploading work, and checking grades. Every assignment and exam will be hosted here. Check frequently for any updates to assignments.
- Use a spreadsheet program like Microsoft Excel or its equivalent for data analysis for labs.

METHODS OF PRESENTATION

- Lab, Lecture and Discussion, Experiments, Group Work, Observation, and Demonstration
- Other Methods: The methods of presentation used in this class reflect the importance of both a conceptual understanding of physics as well as the analytical mastery of the subject. Lecture and class-demonstrations, including computer simulations and videos, are used to introduce topics to students and to ground those ideas. Most experimental work not only reinforces core concepts but teaches experimental measurement techniques and the errors associated with them. Physics Education Research (PER) has shown that active engagement instructional strategies greatly improve student learning. As a result, collaborative learning activities are used in lecture and lab as part of the methods of presentation.

METHODS OF EVALUATION

- Unit Exams: Exams (4 @100 pts each) are mandatory and must be taken when scheduled. Exams will consist of 5 free-response problems that you fully work out. I will provide all physical constants that you will need, and you will make a

hand-written formula sheet on a single 8.5-by-11-inch sheet of paper (both sides), printouts are NOT ALLOWED. Tests are **not** cumulative, but concepts build throughout the course. **The exam dates are 09/22, 10/13, 11/03, and 11/22.** The exams will be 1 hour long and are given at the beginning of the class period.

- Final Exam: This is a cumulative exam that will be given on December 15. It will have 12 questions chosen from the entire course.
- Lab: Labs will be held on Mondays and Wednesdays. The labs that we do will be posted onto Canvas and Gradescope. You are expected to read the week's lab ahead of time, so you can understand before we begin the lab. The experiments can be finished more quickly if you come prepared. Lab reports will be due one week following the lab session, unless otherwise noted. During lab days, we will be breaking up into groups of 3. You will receive a 0 for any missed lab. I will drop your lowest lab score.
- Homework: You will be assigned between 20-30 problems each week. We will be using online homework via Pearson's Mastering Physics. You will be able to make unlimited attempts for each question without penalty. For full credit, you will also submit a scanned written hard copy (or answers written by hand on a digital tablet) to Canvas. Full reasoning for EACH question is required for full credit, "Rules for Homework" for details (INCLUDING multiple choice questions). Anticipate that you will require 6-10 hours to complete the homework each set. Homework will be due at **11:59 PM each Sunday**.
- Pre-lecture and In-class work: In this class, we will have pre-lecture handouts and in-class workgroups. Pre-lecture handouts will cover the material that will be covered in lecture that day, due 30 minutes before the start of class. There are videos that walkthrough the material to complete the pre-lecture handouts. The pre-lecture handouts supplement the textbook reading and help you come to lecture prepared and reduces time spent on homework. Completing the pre-lecture handout prepares you for the in-class work.
  In-class work will be assigned in the class, at differing times in the lecture. We will be breaking up into groups of three (or two), randomly generated, to discuss and solve problems. You will generate a single document (paper or digital) for the group and each group member will take turns writing, so each submission should have each group member's handwriting on it. After a discussion within your group, I encourage you to discuss your work across groups. We will then go over the problem together as a class. You will then upload your work in the class period. In-class work may be excused (with documentation) but cannot be made up.
- A grade of "Incomplete" may be granted at the very end of the term if an unforeseen event or illness prevents you from completing the final coursework and at the time you have earned a "C" or better. "Incomplete" grade situations are extremely rare, and are entirely at the discretion of the instructor, within the parameters set above.

Your final grade will be calculated using the following percentages:

Percentage of Grade:	**Evaluation Method:**
10%	Pre-lecture and In-class work
18%	Lab Reports
14%	Homework
36%	Unit Exams
22%	Final Exam

GRADING SCALE

A = 90.0-100%
B = 80.0-89.9%
C = 65.0-79.9%
D = 55.0-64.9%
F = 54.9% and below

ATTENDANCE, DROPS, & WITHDRAWALS

You are responsible for maintaining your own enrollment status. You may drop the course with a withdrawal until July 19, 2023. It is NOT possible to drop the class that date. General information regarding drop dates, withdrawals, refunds, and other enrollment matters may also be found at the Admissions section of the SMC website. See Admissions Dates and Deadlines for the complete semester schedule including short term courses.

- Attendance is crucial to your success. The class may cover material that is not discussed or found elsewhere, so you will miss out on an essential part of the learning process if absent. Regular attendance is required of every student. You should attend every class, but extenuating circumstances arise that can make this difficult. If you cannot attend a class, please let me know. If circumstances make you miss more than 3 classes during the semester, you may be overextended. I ask that you come see me to discuss your options. Missing 4 class sessions MAY lead you to be dropped from the course.
- Sunday September 24 is the last day to withdraw with no grade showing on your permanent record. Saturday, November 19 is the last day to withdraw from this class with a grade of W. The last day to request for a pass/no pass grade is Monday December 18.
- The date of the final is Friday December 15.

MISSED AND LATE WORK

- Late work is accepted up until the unit exam covering the material, but there is a deduction equal to 20% of the assignment. In addition to wanting to avoid the grade penalty, you should make every effort to submit all work by its deadline so you can receive the prompt feedback and grade that are an essential part of the learning process and success in college. Late pre-lecture and in-class work is not accepted but may be excused with documented extenuating circumstances.
- When absent, you are still responsible for completing and submitting all work on time; however, if you have a documented extenuating circumstance that prevents the timely submission of work, please speak to me as soon as possible to receive an accommodation with a new reasonable deadline.
- Tests are mandatory and must be taken when scheduled. Under compelling circumstances with documentation, they can be made up.

EXTRA CREDIT

You may choose ONE of the following extra credit options. The points will be added to the exam section of your grade.

- You may attend a Distinguished Scientist Lecture and write a two-page analytical reflection paper connecting what you learn at the event to your class materials for up to 10 extra credit points. (You may also watch recorded lectures of scientists, subject to the professor's approval).
- You may participate in the Sustainable Works program for up to 10 extra credit points. For more information visit the Sustainable Works site.

CLASSROOM POLICIES

Class Participation

- Learning is a collaborative exercise; this classroom is your space too! Everyone belongs here, no matter your background. I highly encourage you to be "wrong" here; it is how we learn! If you already knew everything, you wouldn't need me! Sometimes, active participation can feel uncomfortable, particularly if you are unsure of the "answers." One of the themes of this course, as I teach it, is that science (really all knowledge) is a process more than a set of facts. Like a learning a musical instrument, practicing helps us to become better scientists!
- All of us in the class, you, me, your peers, have a responsibility to create an environment in which we can all learn from each other. I expect everyone to participate in class so that we can all benefit from the insights and experiences that each person brings.

- Learning doesn't stop after the class ends; you should all use the course Discord. You should use it to pose homework questions and answer questions of your peers. You can also use it to coordinate in-person and Zoom study groups with each other.

Classroom Environment

- Please ask questions during class
- This classroom is welcoming to all. I expect everyone to be respectful in how they communicate and interact with every person in this class. Racist, sexist, homophobic, and other forms of language that potentially marginalize or demean any student are not tolerated.
- In this class we will be sharing multiple perspectives. Please remember to be respectful with one another.
- Please refrain from having side-conversations during the lecture portions of the class. We will be having several periods for discussions during class time.
- You are expected to follow all Codes of Conduct as established by Santa Monica College. These documents can be reviewed at the Student Judicial Affairs webpage. See the rules for Student Conduct (AR 4410), Code of Academic Conduct (AR 4411), Student Honor Code (AR 4412).

Electronic Devices

- Use of electronic devices such as laptops, smartphones, and tablets are permitted in this class. However, to maximize participation and learning, you should limit this usage to activities supporting concurrent class topics.
- Cell phones and other electronic devices should on silent during class time. I recommend putting all electronics on "do not disturb" mode during class to keep you focused.

Food & Drink

Food or drink is prohibited in the classroom except for water bottles, which are permitted if they remain closed when not in active use and are kept away from all equipment.

Recording of Class Lectures

In accordance with Section 78907 of the California Education Code, students shall not use any electronic listening or recording device in any classroom without the prior consent of the instructor, except as necessary to provide reasonable auxiliary aids and academic adjustments to disabled students.

Homework, In-class work, and Lab Reports

- We will be using online homework via Pearson's Mastering Physics. You will be able to make unlimited attempts for each question with no penalty.
- While you are completing the homework, write out your reasoning FOR ALL PROBLEMS: for simple conceptual questions, a couple of sentences suffice; for longer problems full reasoning, see below in Rule For Homework and In-class Work. You will be submitting this work for half of your homework points.
- The homework in this class can be rather challenging. Anticipate that you will require 6-10 hours to complete the homework each chapter. You will likely need assistance with at least two or three problems per assignment.
- To ensure that you have enough time available to seek assistance, begin working on the problem sets as soon as possible.
- I highly encourage you to work with other students to complete homework problems and lab reports. I do expect that each student turn in their own individual work. You are required to turn in a copy of your own handwritten work onto Canvas. See "Rules For Homework and In-class Work" for expectations.
- If you are unable to do a problem, you may post online on the class Discord for other students help, email me to ask for help (see contact information above), or go to office hours. There are also FREE tutors offer via SMC, (https://www.smc.edu/student-support/academic-support/tutoring-centers/index.php).
- Learning doesn't stop after the class ends; you should all use the course Discord. You should use it to pose homework questions and answer questions of your peers. You can also use it to set up Zoom study groups with each other.

Rules For Homework and In-class work

I want to you to treat each homework problems with the same level of care as you would on an exam. Here, I give a general outline of the rules you should use for your homework assignments. For each type of problem, I will create a guide on how to set-up and solve that problem.

1. General Appearance of Assignment
   a. Handwriting should be neat, legible, and reasonably dark. If the image contrast is not high enough, you will need to re-upload your document. Do not write on both sides if your graphite/ink bleeds through.
   b. Your homework should be logically organized and easy to follow.
   c. Problems must be written in exactly the order assigned. That is, problem 1 should be solved first, then problem 2, etc.
   d. You **must** submit your handwritten work to the "assignment" on Gradescope for credit.
   e. For each assignment please only create **ONE** pdf with your favorite scanning software or app.
   f. On Gradescope, specify which page(s) each problem appears.

2. **You may write only one equation or statement per line.** After you have written one equation on a line, go to the next line to write the next equation. If you write small and find this wasteful, you may draw a line down the middle of your paper to make two columns, and then begin working down the right side of the paper after you have completely used up the left side.

3. The following steps must be followed when STARTING a homework problem:
   a. Draw a diagram which presents all information given in the statement of the problem. The diagram must be large enough for all important information to be represented clearly. It should be clear what type of problem you are solving based on your sketch alone. Any symbolic variables that appear in your math (such as x, t, F, etc.) <u>must</u> either appear in the diagram or be listed next to the diagram.
   b. If appropriate, use your diagram to define a coordinate system by drawing coordinate axes or noting which direction is positive.
   c. If information is given as a numerical value (such as 3.0 m, 12.0 s, 8.0 N, etc.), a symbol (such as x, t, F, etc.) must be assigned to the numerical value. For example, if a problem says that a box has a mass of 3.0 kg, you should write "m = 3.0 kg" (if you have more than one use subscripts: m_A, m_B, etc.) on your paper, on or next to the diagram. Do not simply write "3.0kg"; assign a symbol and write "m = 3.0kg". Use a single letter for each numerical value.

4. To begin COMPUTATION: Start your solution by stating one or more equations you have seen either in lecture or in the text (e.g., $F = ma$, $\Delta x = v_{av}\Delta t$, etc.) that is appropriate to the problem at hand. The first equation in a problem should NEVER have numerical values plugged into it; it should be strictly in "variable" form.

5. When FINISHING a problem: If you have an equation in which the variable you are trying to solve for appears, and all other quantities are known, follow the following steps:
   a. WITHOUT PLUGGING IN NUMBERS, isolate the variable. Exceptions: (1) You may always plug in zero. (2) When you have obtained a quadratic equation, you may work out numerical values for the coefficients, and then plug numerical values for the coefficients into the quadratic formula.
   b. Once you have an equation in which the variable is isolated on one side, plug numerical values (if given) into the quantities on the other side of the equation. **When you plug numerical values into an equation, you must include units with the numerical values.** (See item 6, below.)
   c. Compute the numerical value of the quantity of interest.

6. USE THE CORRECT UNITS.
   a. Every numerical answer must include the correct unit.
   b. Any time a number representing a physical quantity appears in a solution, units must be included. Do not insert numbers into an equation without inserting the accompanying units.

Example:	Example:
~~$\Delta x = v\Delta t$~~	$\Delta x = v\Delta t$
~~$\Delta x = (4)(2)$~~	$\Delta x = (4\text{m/s})(2\text{s})$
~~$\Delta x = 8\text{m}$~~	$\Delta x = 8\text{m}$
~~**WRONG**~~	**RIGHT**

c. Check to make sure that the correct unit for your answer follows from the computation; do not just "tack on" the correct unit at the end of the problem. This generally requires a simple computation. An example follows:

Example: Suppose you wish to compute the acceleration of a 5-kg object subject to a single 10-N force. You would write:

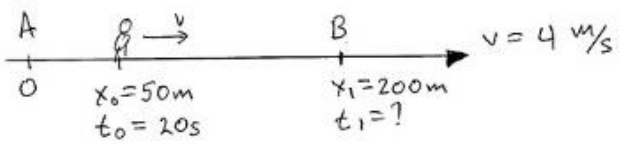
$$a = \frac{F}{m} = \frac{10\ N}{5\ kg} = \frac{10\cancel{kg}\bullet m/s^2}{5\ \cancel{kg}} = 2\text{m/s}^2$$

Notice that expanding "N" into "kg•m/s^2" allows you to cancel the "kg", leaving m/s^2, which is the correct unit for acceleration.

Example of Homework Presentation

The following example illustrates the use of Homework Rules.

Problem:
A jogger is running in a straight line from point A to point B, which are separated by 200. m. He maintains a constant speed of 4.00 m/s. If the jogger is presently 50.0 m from A (and 150 m from B), and his stopwatch reads 20.0 s, what will be the reading on his stopwatch when he reaches B?



$$x_1 = x_0 + v(t_1 - t_0)$$

$$\frac{x_1 - x_0}{v} = t_1 - t_0$$

$$t_1 = t_0 + \frac{x_1 - x_0}{v}$$

$$t_1 = 20s + \frac{200m - 50m}{4\ m/s}$$

$$t_1 = 20s + 37.5s$$

$$\boxed{t_1 = 57.5s}$$

Uploading Work to Gradescope

For this class, I will be using Gradescope (as integrated to Canvas) for all assignments for this course. You will be able to see a rubric for all the assignments and submit regrade requests via Gradescope. Besides exams (that I will upload after you complete them), you will upload all your work. Since homework and labs are varying length, make sure to identify which pages each problem from the homework and sections of the lab appear on for me to grade your work properly. Pre-lecture handouts are templated, so make sure to scan and submit ALL pages of the handout.

ACADEMIC HONESTY

The SMC Honor statement, signed by each student upon enrollment, reads: "In the pursuit of the high ideals and rigorous standards of academic life, I commit myself to respect and uphold the Santa Monica College Honor Code, Code of Academic Conduct, and Student Conduct Code. I will conduct myself honorably as a responsible member of the SMC community in all endeavors I pursue." Please be extremely careful that you do not engage in any behavior that could even be construed as cheating. Violations could result in failing grades, reports to the Campus Disciplinarian, and subsequent academic disciplinary action. Examples of behaviors that are not permitted include but are not limited to: inappropriate language or physicality in the classroom, and inappropriate behaviors during an exam (talking with another student, looking at or copying from another student's paper, using a disallowed electronic device or calculator, using disallowed notes, leaving the room without prior permission, removing exam materials from the classroom).

ACCOMMODATIONS FOR DISABILITIES

I encourage students requesting disability-related accommodations to contact the Center for Students with Disabilities as soon as possible. I will work with you and the Center for Students with Disabilities to provide appropriate and reasonable accommodations. An early notification of your request for test-taking and/or other accommodations is necessary to ensure that your disability-related needs are addressed appropriately; testing accommodations cannot be applied retroactively.

The Center for Students with Disabilities is located on the first floor of the Student Services Center, and the phone number is (310) 434-4265 or email at dsps@smc.edu Additional Contact Information can be found at the Center for Students with Disabilities website.

EMERGENCY PREPAREDNESS & SAFETY

The safety of students at SMC is a priority. In the event of an emergency, you should contact the SMC Police Department (310-434-4300).

Please note that emergency procedures are posted in this classroom and every classroom. Please take the time to familiarize yourself with these procedures today, when knowledge of what to do can be the most effective. Also, procedures for various emergencies are delineated on the SMC Emergency Preparedness website.

We strongly encourage everyone to use the LiveSafe mobile app that Santa Monica College is providing to all students, faculty, and staff to download for free. The app provides a quick, convenient, and discreet way to communicate directly with Santa Monica College officials, enhancing your overall safety and allowing Santa Monica College to better serve you. Please use the app to anonymously report any acts of vandalism you may observe.

EMOTIONAL SUPPORT

Over the course of the semester, you may face difficult circumstances beyond your control, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down or depressed, or having difficulty concentrating. Having any of these challenges may create barriers to learning or may make it difficult for you to meet some of the course requirements. If you or someone you know is suffering these or other similarly difficult circumstances, please reach out for support. The staff and faculty of Santa Monica College want you to succeed academically and care about your wellbeing. You may contact the college's Center for Wellness and Wellbeing (LA 110, 310-4344503), which provides short-term mental health services, community referrals, and a 24/7 emotional support line 800-691-6003. Or, if the situation is an emergency, you may contact the SMC Police Department (310-434-4300 or the SMC LiveSafe app). Also, please feel you can contact me so that I can help to direct you to support services on campus that might be most beneficial to you.

EQUITABLE LEARNING ENVIRONMENT

Santa Monica College is an intellectual community enriched and enhanced by diversity along a number of dimensions, including race, ethnicity and national origins, gender and gender identity, disability, sexuality, class and religion. We are especially committed to increasing the representation of those populations that have been historically minoritized in U.S. higher education.

GENDER EXPRESSION AND IDENTITY

I will gladly honor your request to address you by an alternate/preferred name or gender pronoun. Please advise me of this preference early in the semester or session so that I may make appropriate changes to my records. I will do my best to address and refer to all students accordingly and support classmates in doing so as well.

TITLE IX (SEX DISCRIMINATION)

Title IX is a comprehensive federal law that prohibits discrimination on the basis of sex in any federally funded education program or activity: No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving federal financial assistance.

Those interested in the details should view the Title IX Legal Manual.

Students who have experienced some form of sexual misconduct or discrimination are encouraged to talk to someone about their experience, so they can get the support they need. You can learn more about available support at the Student Services Title IX webpage.

UNDOCUMENTED/DACA/AB540

Santa Monica College stands with the California Community Colleges Chancellor's Office—and hundreds of other educational and business organizations—in affirming that our undocumented students are as integral a part of our community as anyone else. Here at Santa Monica College, we remain committed to serving our undocumented students, to helping them fulfill their life's dreams and aspirations; this college will continue to be a safe environment for all students and personnel. We will work to provide the greatest support to students affected by this decision, and campus and student leaders alike have already rallied in solidarity as well as to provide resources. SMC joins the Chancellor's Office and all the other voices that will advocate determinedly in Congress for an effective solution to this issue, to end a cruel and unnecessary action that goes against the interests of local communities and our country at large.

The **Santa Monica College DREAM Program** provides support services to DREAMers (undocumented, AB540 and DACA recipients). Its purpose is to increase the personal growth, development and retention of DREAM students through academic, career, and personal counseling; assistance in applying for the California Dream Act/Financial Aid and scholarships; and providing workshops relative to DREAMers and their families. The Dream Program is located in the Student Services Center (SSC) 2nd Floor, Room 238. To make an appointment, call (310) 434-4892 or email DREAM@smc.edu.

STUDENT SUCCESS

Academic Counseling

The Counseling Department at SMC can help you with choosing and enrolling in classes, educational and career planning, navigating Corsair Connect, understanding financial aid, referrals to campus resources, and more.

Black Collegians

The Black Collegians Program/Umoja Community at SMC is designed to assist students of African descent in transferring to four-year universities and obtaining their associate degree. They offer services to help students become academically competitive and to set personal goals.

Extended Opportunity Program & Service (EOPS)
Extended Opportunity Program & Services (EOPS) at Santa Monica College is a program that supports the enrollment, retention, graduation, and transfer of students who are challenged by economic and educational disadvantages. They offer service such as academic, career, personal and transfer counseling; priority registration; supplemental textbook assistance; one-on-one tutoring; and much more.

Latino Center/Adelante
The Adelante Program is a success-oriented program focusing on academic achievement, transfer, cultural awareness, and personal growth. Adelante classes emphasize verbal, written, and critical thinking skills essential to college success. Classes accentuate the Latino experience within the context of the course subject, and most classes offer credits that are transferable to the UC and CSU systems.

Student Health Services Center
The SMC Health Services Center provides primary health care services to currently enrolled Santa Monica College students who have paid the California State mandated health fee. It focuses on health promotion, illness prevention, referrals, health and nutrition education. The staff consists of two registered nurses, a registered dietitian, two health assistants, and a nurse practitioner. The Center is located on the northeast corner of the Cayton Center Complex.

Tutoring
Free tutoring centers are available across the campus. There are dedicated centers for Business, CSIS, ESL, Math, Modern Languages, Science, and Writing & Humanities tutoring. For more information about their hours and locations, visit the SMC Tutoring Services Webpage.

Veterans Resource Center
The Veterans Resource Center at Santa Monica College serves veterans entering college for the first time or returning to college to further their education. The office acts as a liaison with the Veterans Administration verifying enrollment for students claiming benefits under the G.I. Bill or the Veterans' Vocational Rehabilitation Program. It also can also assist the veteran with referrals to various veteran-serving programs in the West Los Angeles area. If you would like additional information, please call (310) 434-8205.

STUDENT SERVICES CENTER

Located at the North end of campus on the corner of Pico and 20th street.

- Admissions & Records
- Black Collegians
- CalWORKs
- Care & Prevention Team
- Career Services Center
- Cashier's Office
- Center for Students with Disabilities
- Counseling
- Distance Education
- DREAM Program
- EOPS/CARE
- Financial Aid & Scholarships
- Guardian Scholars
- High Tech Center
- Institutional Research
- International Education Center
- Latino Center
- Pico Partnership
- Scholars Program
- Student Judicial Affairs
- Success & Engagement Center
- Transfer Counseling Center
- Welcome Center

DISCLAIMER

Some elements of the syllabus may be changed at the instructor's discretion. Students will be given at least 48 hours notice of changes whenever possible. If there is any aspect of this syllabus which you do not understand, or to which you take exception, please let the instructor know within the first week of class. Your continued attendance in this course constitutes an acknowledgement and acceptance of the requirements delineated in this syllabus.

Week #	Date (Monday)	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
1	08-28	Introduction LECTURE Chapter 1.1-1.5		LECTURE Chapter 1.6-1.8 EXP #1 Measurement and Errors		LECTURE Chapter 1.9-1.10 EXP #2 Vector Quantities and the Force Table
2	09-04	**LABOR DAY HOLIDAY**		LECTURE Chapter 2.1-2.4 EXP #3 Kinematic Diagrams		LECTURE Chapter 2.4-2.6
3	09-11	LECTURE Chapter 2.6 Chapter 3.1-3.3		LECTURE Chapter 3.3-3.4 EXP #4 Motion of a Freely Falling Body		LECTURE Chapter 3.5
4	09-18	LECTURE Chapter 4.1-4.3		LECTURE Chapter 4.5-4.6 EXP #5 Projectile Motion		**EXAM 1 CH 1-3**
5	09-25	LECTURE Chapter 4.5-4.6 EXP #6 Newton's 1st and 3rd Laws Part 1 Friction and Inclined Planes DROP DEADLINE! (09/24 without W)		LECTURE Chapter 5.1-5.3 EXP #7 Newton's 1st and 3rd Laws Part 2 Pulleys		LECTURE Chapter 5.4-5.5
6	10-02	LECTURE Chapter 5 (Practice Problems)		LECTURE Chapter 5 (Practice Problems) EXP #8 Dynamics of Circular Motion		LECTURE Chapter 6.1-6.2
7	10-09	LECTURE Chapter 6.3-6.4		LECTURE Chapter 7.1-7.3 EXP #9 Newton's 2nd Law (Dynamics)		**EXAM 2 CH 4-5**

8	10-16	LECTURE Chapter 7.3-7.5		LECTURE Chapter 8.1-8.2 LECTURE EXP #10 Conservation of Energy		LECTURE Chapter 8.3-8.4
9	10-23	LECTURE Chapter 8.5-8.6		LECTURE Chapter 9.1-9.2 EXP #11 Momentum and Collisions		LECTURE Chapter 9.3-9.4
10	10-30	LECTURE Chapter 9.4-9.6		LECTURE Chapter 10.1-10.2 EXP #12 Ballistic Pendulum		**EXAM 3 CH 6-8**
11	11-06	LECTURE Chapter 10.3-10.4		LECTURE Chapter 10.5-10.7 EXP #13 Torque and Moment of Inertia		LECTURE Chapter 10 Practice Problems
12	11-13	LECTURE Chapter 11.1-11.2		LECTURE Chapter 11.4-11.5 EXP #14 Rotational Equilibrium		LECTURE Chapter 11 Practice Problems DROP DEADLINE! (11/18 with W)
13	11-20	LECTURE Chapter 13.1-13.3 EXP #15 Conservation of Angular Momentum		**EXAM 4 CH 9-11** LECTURE Chapter 13.4-13.5	**THANKSGIVING**	**NATIVE AMERICAN HERITAGE DAY**
14	11-27	LECTURE Chapter 13.6-13.8		LECTURE Chapter 14.1-14.3 EXP #16 Simple Harmonic Motion		LECTURE Chapter 14.4-14.6
15	12-04	LECTURE Chapter 14.7-14.8 EXP #17 Physical Pendulum		LECTURE Chapter 12.1-12.3 EXP #18 Damped Oscillation and Resonance		LECTURE Chapter 12.4-12.5
16	12-11	LECTURE Chapter 12.6 Review				**FINAL EXAM** **12–3 PM**
17	12-19					

PHYSICS 23, WAVES, OPTICS, THERMO DYNAMICS

FALL 2023

COURSE INFORMATION

Course Title:	PHYSICS 21, WAVES, OPTICS, THERMO DYNAMICS
Section Number:	3023
Units:	5.00 units
Prerequisite(s) or Advisories:	Physics 21 and Math 8 with a grade of C or better.
Day and Time:	Monday, Wednesday 8:45 AM –10:50 AM
Location:	SCI 122
Day and Time:	Friday 8:45 AM –11:45 AM
Location:	SCI 106

INSTRUCTOR INFORMATION

Instructor:	Kevin Roberts
Email Address:	Roberts_kevin31@smc.edu
Office Hours:	Monday, Wednesday 02:20–4:00 PM in SCI 275 Additional Meetings on Zoom by Appointment (Meeting ID: 809 988 3587, Password: SMCPhys)

I welcome you to contact me outside of class and student hours. You may email me, message me on Canvas or tag me on the class Discord. You may also make office hours by appointment.

COURSE DESCRIPTION

This course is a calculus-based study of the wave motion, heat, kinetic theory, and optics. It is designed for engineering, physical science, and computer science majors.

COURSE OBJECTIVES

Upon completion of this course, the student will be able to:

1. Use basic concepts in physics to construct a qualitative explanation of physical phenomena.
2. Use physical principles and laws to construct a quantitative explanation of physical phenomena through mathematical analysis.
3. Utilize various mathematical methods such as algebra, trigonometry, and calculus, to navigate through the quantitative analysis of a physical problem.
4. Proficiently operate and adjust laboratory equipment to obtain quantitative measurements in a physics experiment.
5. Estimate the uncertainty of a measurement and the propagation of error for results dependent upon the measurement.
6. Use various computational tools such as spreadsheets and graphing programs to analyze data.
7. Compose organized and thorough analyses of work done in the laboratory.

STUDENT & INSTITUTIONAL LEARNING OUTCOMES

1. When presented with a physical situation and asked to solve a particular problem in thermodynamics, wave phenomena, or optics, the student will follow a logical process based on well-established physics principles (i.e. laws of thermodynamics) and demonstrate ability to use basic mathematical techniques, including calculus.

2. When conducting a laboratory experiment and writing a lab report, the student will demonstrate understanding of the basics of the scientific method by being able to state a clear and testable hypothesis, taking careful measurements, estimating uncertainties, and drawing appropriate conclusions based on gathered data and on sound scientific principles.

REQUIRED TEXTS, MATERIALS, & SUPPLIES

1. Young, Freedman, and Ford, University Physics with Modern Physics. 15th ed. WITH MASTERING PHYSICS REQUIRED
   You can get either the digital or hard cover versions if you have an unused Mastering code. We will be using it for online homework.
2. Scientific or graphing calculator. You may use Desmos or Wolfram Alpha.
3. Computer and Internet access.
4. Installed desktop Microsoft office. (Free via SMC)
5. Notebook and writing implement(s) (digital tablets are an acceptable option)

RECOMMENDED RESOURCES & SKILLS

Supplementary Texts

1. Adelson, Get ready for physics
2. McMullen, Essential Calculus-based Physics Study Guide Workbook: Laws of Motion, Volume 3

Computer Skills

To succeed in this course, you should have the ability to:

- Navigate the Internet using a web browser.
- Manage files using either the Mac or Windows operating systems.
- Send and receive email messages and attachments.
- Use a word processing program like Microsoft Word or its equivalent.
- Navigating Canvas: checking assignment deadlines, uploading work, and checking grades. Every assignment and exam will be hosted here. Check frequently for any updates to assignments.
- Use a spreadsheet program like Microsoft Excel or its equivalent for data analysis for labs.

METHODS OF PRESENTATION

- Lab, Lecture and Discussion, Experiments, Group Work, Observation, and Demonstration
- Other Methods: The methods of presentation used in this class reflect the importance of both a conceptual understanding of physics as well as the analytical mastery of the subject. Lecture and class-demonstrations, including computer simulations and videos, are used to introduce topics to students and to ground those ideas. Most experimental work not only reinforces core concepts but teaches experimental measurement techniques and the errors associated with them. Physics Education Research (PER) has shown that active engagement instructional strategies greatly improve student learning. As a result, collaborative learning activities are used in lecture and lab as part of the methods of presentation.

METHODS OF EVALUATION

- Unit Exams: Exams (3 @100 pts each) are mandatory and must be taken when scheduled. Exams will consist of 5 free-response problems that you fully work out. I will provide all physical constants that you will need, and you will make a **hand-written** formula sheet on a single 8.5-by-11-inch sheet of paper (both sides), printouts are NOT ALLOWED. Tests are **not** cumulative, but concepts build throughout the course. **The exam dates are 10/02, 10/23, and 11/13.** The exams will be 1 hour long and are given at the beginning of the class period.
- Final Exam: This is a cumulative exam that will be given on December 13. It will have 12 questions chosen from the entire course.
- Lab: Labs will be held on Fridays. The labs that we do will be posted onto Canvas and Gradescope. You are expected to read the week's lab ahead of time, so you can understand before we begin the lab. The experiments can be finished

more quickly if you come prepared. Lab reports will be due one week following the lab session, unless otherwise noted. During lab days, we will be breaking up into groups of 3. You will receive a 0 for any missed lab. I will drop your lowest lab score.

- Homework: You will be assigned between 20-30 problems each chapter. We will be using online homework via Pearson's Mastering Physics. You will be able to make unlimited attempts for each question without penalty. For full credit, you will also submit a scanned written hard copy (or answers written by hand on a digital tablet) to Canvas. Full reasoning for EACH question is required for full credit, "Rules for Homework" for details. Anticipate that you will require 6-10 hours to complete the homework each set. Homework will be due at **11:59 PM each Sunday**.
- Pre-lecture and In-class work: In this class, we will have pre-lecture handouts and in-class workgroups. Pre-lecture handouts will cover the material that will be covered in lecture that day, due 30 minutes before the start of class. There are videos that walkthrough the material to complete the pre-lecture handouts. The pre-lecture handouts supplement the textbook reading and help you come to lecture prepared and reduces time spent on homework. Completing the pre-lecture handout prepares you for the in-class work.
  In-class work will be assigned in the class, at differing times in the lecture. We will be breaking up into groups of three (or two), randomly generated, to discuss and solve problems. You will generate a single document (paper or digital) for the group and each group member will take turns writing, so each submission should have each group member's handwriting on it. After a discussion within your group, I encourage you to discuss your work across groups. We will then go over the problem together as a class. You will then upload your work in the class period. In-class work may be excused (with documentation) but cannot be made up.
- A grade of "Incomplete" may be granted at the very end of the term if an unforeseen event or illness prevents you from completing the final coursework and at the time you have earned a "C" or better. "Incomplete" grade situations are extremely rare, and are entirely at the discretion of the instructor, within the parameters set above.

Your final grade will be calculated using the following percentages:

Percentage of Grade:	**Evaluation Method:**
10%	Pre-lecture and In-class work
18%	Lab Reports
14%	Homework
36%	Unit Exams
22%	Final Exam

GRADING SCALE

A = 90.0-100%
B = 80.0-89.9%
C = 65.0-79.9%
D = 55.0-64.9%
F = 54.9% and below

ATTENDANCE, DROPS, & WITHDRAWALS

You are responsible for maintaining your own enrollment status. You may drop the course with a withdrawal until July 19, 2023. It is NOT possible to drop the class that date. General information regarding drop dates, withdrawals, refunds, and other enrollment matters may also be found at the Admissions section of the SMC website. See Admissions Dates and Deadlines for the complete semester schedule including short term courses.

- Attendance is crucial to your success. The class may cover material that is not discussed or found elsewhere, so you will miss out on an essential part of the learning process if absent. Regular attendance is required of every student. You should attend every class, but extenuating circumstances arise that can make this difficult. If you cannot attend a class, please let me know. If circumstances make you miss more than 3 classes during the semester, you may be

overextended. I ask that you come see me to discuss your options. Missing 4 class sessions MAY lead you to be dropped from the course.

- Sunday September 24 is the last day to withdraw with no grade showing on your permanent record. Saturday, November 19 is the last day to withdraw from this class with a grade of W. The last day to request for a pass/no pass grade is Monday December 18.
- The date of the final is Wednesday December 13.

MISSED AND LATE WORK

- Late work is accepted up until the unit exam covering the material, but there is a deduction equal to 20% of the assignment. In addition to wanting to avoid the grade penalty, you should make every effort to submit all work by its deadline so you can receive the prompt feedback and grade that are an essential part of the learning process and success in college. Late pre-lecture and in-class work is not accepted but may be excused with documented extenuating circumstances.
- When absent, you are still responsible for completing and submitting all work on time; however, if you have a documented extenuating circumstance that prevents the timely submission of work, please speak to me as soon as possible to receive an accommodation with a new reasonable deadline.
- Tests are mandatory and must be taken when scheduled. Under compelling circumstances with documentation, they can be made up.

EXTRA CREDIT

You may choose ONE of the following extra credit options. The points will be added to the exam section of your grade.

- You may attend a Distinguished Scientist Lecture and write a two-page analytical reflection paper connecting what you learn at the event to your class materials for up to 10 extra credit points. (You may also watch recorded lectures of scientists, subject to the professor's approval).
- You may participate in the Sustainable Works program for up to 10 extra credit points. For more information visit the Sustainable Works site.

CLASSROOM POLICIES

Class Participation

- Learning is a collaborative exercise; this classroom is your space too! Everyone belongs here, no matter your background. I highly encourage you to be "wrong" here; it is how we learn! If you already knew everything, you wouldn't need me! Sometimes, active participation can feel uncomfortable, particularly if you are unsure of the "answers." One of the themes of this course, as I teach it, is that science (really all knowledge) is a process more than a set of facts. Like a learning a musical instrument, practicing helps us to become better scientists!
- All of us in the class, you, me, your peers, have a responsibility to create an environment in which we can all learn from each other. I expect everyone to participate in class so that we can all benefit from the insights and experiences that each person brings.
- Learning doesn't stop after the class ends; you should all use the course Discord. You should use it to pose homework questions and answer questions of your peers. You can also use it to coordinate in-person and Zoom study groups with each other.

Classroom Environment

- Please ask questions during class
- This classroom is welcoming to all. I expect everyone to be respectful in how they communicate and interact with every person in this class. Racist, sexist, homophobic, and other forms of language that potentially marginalize or demean any student are not tolerated.
- In this class we will be sharing multiple perspectives. Please remember to be respectful with one another.
- Please refrain from having side-conversations during the lecture portions of the class. We will be having several periods for discussions during class time.

- You are expected to follow all Codes of Conduct as established by Santa Monica College. These documents can be reviewed at the Student Judicial Affairs webpage. See the rules for Student Conduct (AR 4410), Code of Academic Conduct (AR 4411), Student Honor Code (AR 4412).

Electronic Devices

- Use of electronic devices such as laptops, smartphones, and tablets are permitted in this class. However, to maximize participation and learning, you should limit this usage to activities supporting concurrent class topics.
- Cell phones and other electronic devices should on silent during class time. I recommend putting all electronics on "do not disturb" mode during class to keep you focused.

Food & Drink

Food or drink is prohibited in the classroom except for water bottles, which are permitted if they remain closed when not in active use and are kept away from all equipment.

Recording of Class Lectures

In accordance with Section 78907 of the California Education Code, students shall not use any electronic listening or recording device in any classroom without the prior consent of the instructor, except as necessary to provide reasonable auxiliary aids and academic adjustments to disabled students.

Homework, In-class work, and Lab Reports

- We will be using online homework via Pearson's Mastering Physics. You will be able to make unlimited attempts for each question with no penalty.
- While you are completing the homework, write out your reasoning FOR ALL PROBLEMS: for simple conceptual questions, a couple of sentences suffice; for longer problems full reasoning, see below in Rule For Homework and In-class Work. You will be submitting this work for half of your homework points.
- The homework in this class can be rather challenging. Anticipate that you will require 6-10 hours to complete the homework each chapter. You will likely need assistance with at least two or three problems per assignment.
- To ensure that you have enough time available to seek assistance, begin working on the problem sets as soon as possible.
- I highly encourage you to work with other students to complete homework problems and lab reports. I do expect that each student turn in their own individual work. You are required to turn in a copy of your own handwritten work onto Canvas. See "Rules For Homework and In-class Work" for expectations.
- If you are unable to do a problem, you may post online on the class Discord for other students help, email me to ask for help (see contact information above), or go to office hours. There are also FREE tutors offer via SMC, (https://www.smc.edu/student-support/academic-support/tutoring-centers/index.php).
- Learning doesn't stop after the class ends; you should all use the course Discord. You should use it to pose homework questions and answer questions of your peers. You can also use it to set up Zoom study groups with each other.

Rules For Homework and In-class work

I want to you to treat each homework problems with the same level of care as you would on an exam. Here, I give a general outline of the rules you should use for your homework assignments. For each type of problem, I will create a guide on how to set-up and solve that problem.

1. General Appearance of Assignment
   a. Handwriting should be neat, legible, and reasonably dark. If the image contrast is not high enough, you will need to re-upload your document. Do not write on both sides if your graphite/ink bleeds through.
   b. Your homework should be logically organized and easy to follow.
   c. Problems must be written in exactly the order assigned. That is, problem 1 should be solved first, then problem 2, etc.
   d. You **must** submit your handwritten work to the "assignment" on Gradescope for credit.
   e. For each assignment please only create **ONE** pdf with your favorite scanning software or app.

f. On Gradescope, specify which page(s) each problem appears.

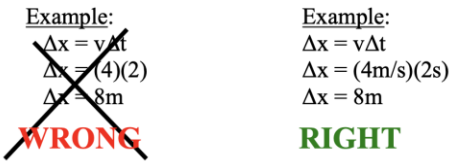
2. **You may write only one equation or statement per line.** After you have written one equation on a line, go to the next line to write the next equation. If you write small and find this wasteful, you may draw a line down the middle of your paper to make two columns, and then begin working down the right side of the paper after you have completely used up the left side.

3. The following steps must be followed when STARTING a homework problem:
   a. Draw a diagram which presents all information given in the statement of the problem. The diagram must be large enough for all important information to be represented clearly. It should be clear what type of problem you are solving based on your sketch alone. Any symbolic variables that appear in your math (such as *x*, *t*, *F*, etc.) <u>must</u> either appear in the diagram or be listed next to the diagram.
   b. If appropriate, use your diagram to define a coordinate system by drawing coordinate axes or noting which direction is positive.
   c. If information is given as a numerical value (such as 3.0 m, 12.0 s, 8.0 N, etc.), a symbol (such as *x*, *t*, *F*, etc.) must be assigned to the numerical value. For example, if a problem says that a box has a mass of 3.0 kg, you should write "*m* = 3.0 kg" (if you have more than one use subscripts: m_A, m_B, etc.) on your paper, on or next to the diagram. Do not simply write "3.0kg"; assign a symbol and write "*m* = 3.0kg". Use a single letter for each numerical value.

4. To begin COMPUTATION: Start your solution by stating one or more equations you have seen either in lecture or in the text (e.g., $F = ma$, $\Delta x = v_{av}\Delta t$, etc.) that is appropriate to the problem at hand. The first equation in a problem should NEVER have numerical values plugged into it; it should be strictly in "variable" form.

5. When FINISHING a problem: If you have an equation in which the variable you are trying to solve for appears, and all other quantities are known, follow the following steps:
   a. WITHOUT PLUGGING IN NUMBERS, isolate the variable. Exceptions: (1) You may always plug in zero. (2) When you have obtained a quadratic equation, you may work out numerical values for the coefficients, and then plug numerical values for the coefficients into the quadratic formula.
   b. Once you have an equation in which the variable is isolated on one side, plug numerical values (if given) into the quantities on the other side of the equation. **When you plug numerical values into an equation, you must include units with the numerical values.** (See item 6, below.)
   c. Compute the numerical value of the quantity of interest.

6. USE THE CORRECT UNITS.
   a. Every numerical answer must include the correct unit.
   b. Any time a number representing a physical quantity appears in a solution, units must be included. Do not insert numbers into an equation without inserting the accompanying units.



   c. Check to make sure that the correct unit for your answer follows from the computation; do not just "tack on" the correct unit at the end of the problem. This generally requires a simple computation. An example follows:

Example: Suppose you wish to compute the acceleration of a 5-kg object subject to a single 10-N force. You would write:

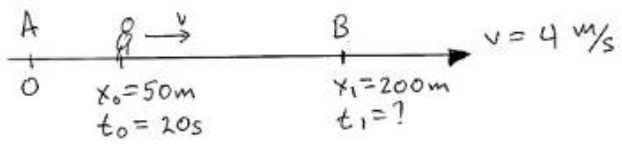
$$a = \frac{F}{m} = \frac{10\ N}{5\ kg} = \frac{10\cancel{kg}\bullet m/s^2}{5\ \cancel{kg}} = 2\text{m/s}^2$$

Notice that expanding "N" into "kg•m/s^2" allows you to cancel the "kg", leaving m/s^2, which is the correct unit for acceleration.

Example of Homework Presentation

The following example illustrates the use of Homework Rules.

Problem:
A jogger is running in a straight line from point A to point B, which are separated by 200. m. He maintains a constant speed of 4.00 m/s. If the jogger is presently 50.0 m from A (and 150 m from B), and his stopwatch reads 20.0 s, what will be the reading on his stopwatch when he reaches B?



$$x_1 = x_0 + v(t_1 - t_0)$$

$$\frac{x_1 - x_0}{v} = t_1 - t_0$$

$$t_1 = t_0 + \frac{x_1 - x_0}{v}$$

$$t_1 = 20s + \frac{200m - 50m}{4\ m/s}$$

$$t_1 = 20s + 37.5s$$

$$\boxed{t_1 = 57.5s}$$

Uploading Work to Gradescope

For this class, I will be using Gradescope (as integrated to Canvas) for all assignments for this course. You will be able to see a rubric for all the assignments and submit regrade requests via Gradescope. Besides exams (that I will upload after you complete them), you will upload all your work. Since homework and labs are varying length, make sure to identify which pages each problem from the homework and sections of the lab appear on for me to grade your work properly. Pre-lecture handouts are templated, so make sure to scan and submit ALL pages of the handout.

ACADEMIC HONESTY

The SMC Honor statement, signed by each student upon enrollment, reads: “In the pursuit of the high ideals and rigorous standards of academic life, I commit myself to respect and uphold the Santa Monica College Honor Code, Code of Academic Conduct, and Student Conduct Code. I will conduct myself honorably as a responsible member of the SMC community in all endeavors I pursue.” Please be extremely careful that you do not engage in any behavior that could even be construed as cheating. Violations could result in failing grades, reports to the Campus Disciplinarian, and subsequent academic disciplinary action. Examples of behaviors that are not permitted include but are not limited to: inappropriate language or physicality in the classroom, and inappropriate behaviors during an exam (talking with another student, looking at or copying from another student's paper, using a disallowed electronic device or calculator, using disallowed notes, leaving the room without prior permission, removing exam materials from the classroom).

ACCOMMODATIONS FOR DISABILITIES

I encourage students requesting disability-related accommodations to contact the Center for Students with Disabilities as soon as possible. I will work with you and the Center for Students with Disabilities to provide appropriate and reasonable

accommodations. An early notification of your request for test-taking and/or other accommodations is necessary to ensure that your disability-related needs are addressed appropriately; testing accommodations cannot be applied retroactively.

The Center for Students with Disabilities is located on the first floor of the Student Services Center, and the phone number is (310) 434-4265 or email at dsps@smc.edu Additional Contact Information can be found at the Center for Students with Disabilities website.

EMERGENCY PREPAREDNESS & SAFETY

The safety of students at SMC is a priority. In the event of an emergency, you should contact the SMC Police Department (310-434-4300).

Please note that emergency procedures are posted in this classroom and every classroom. Please take the time to familiarize yourself with these procedures today, when knowledge of what to do can be the most effective. Also, procedures for various emergencies are delineated on the SMC Emergency Preparedness website.

We strongly encourage everyone to use the LiveSafe mobile app that Santa Monica College is providing to all students, faculty, and staff to download for free. The app provides a quick, convenient, and discreet way to communicate directly with Santa Monica College officials, enhancing your overall safety and allowing Santa Monica College to better serve you. Please use the app to anonymously report any acts of vandalism you may observe.

EMOTIONAL SUPPORT

Over the course of the semester, you may face difficult circumstances beyond your control, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down or depressed, or having difficulty concentrating. Having any of these challenges may create barriers to learning or may make it difficult for you to meet some of the course requirements. If you or someone you know is suffering these or other similarly difficult circumstances, please reach out for support. The staff and faculty of Santa Monica College want you to succeed academically and care about your wellbeing. You may contact the college's Center for Wellness and Wellbeing (LA 110, 310-4344503), which provides short-term mental health services, community referrals, and a 24/7 emotional support line 800-691-6003. Or, if the situation is an emergency, you may contact the SMC Police Department (310-434-4300 or the SMC LiveSafe app). Also, please feel you can contact me so that I can help to direct you to support services on campus that might be most beneficial to you.

EQUITABLE LEARNING ENVIRONMENT

Santa Monica College is an intellectual community enriched and enhanced by diversity along a number of dimensions, including race, ethnicity and national origins, gender and gender identity, disability, sexuality, class and religion. We are especially committed to increasing the representation of those populations that have been historically minoritized in U.S. higher education.

GENDER EXPRESSION AND IDENTITY

I will gladly honor your request to address you by an alternate/preferred name or gender pronoun. Please advise me of this preference early in the semester or session so that I may make appropriate changes to my records. I will do my best to address and refer to all students accordingly and support classmates in doing so as well.

TITLE IX (SEX DISCRIMINATION)

Title IX is a comprehensive federal law that prohibits discrimination on the basis of sex in any federally funded education program or activity: No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving federal financial assistance.

Those interested in the details should view the Title IX Legal Manual.

Students who have experienced some form of sexual misconduct or discrimination are encouraged to talk to someone about their experience, so they can get the support they need. You can learn more about available support at the Student Services Title IX webpage.

UNDOCUMENTED/DACA/AB540

Santa Monica College stands with the California Community Colleges Chancellor's Office—and hundreds of other educational and business organizations—in affirming that our undocumented students are as integral a part of our community as anyone else. Here at Santa Monica College, we remain committed to serving our undocumented students, to helping them fulfill their life's dreams and aspirations; this college will continue to be a safe environment for all students and personnel. We will work to provide the greatest support to students affected by this decision, and campus and student leaders alike have already rallied in solidarity as well as to provide resources. SMC joins the Chancellor's Office and all the other voices that will advocate determinedly in Congress for an effective solution to this issue, to end a cruel and unnecessary action that goes against the interests of local communities and our country at large.

The **Santa Monica College DREAM Program** provides support services to DREAMers (undocumented, AB540 and DACA recipients). Its purpose is to increase the personal growth, development and retention of DREAM students through academic, career, and personal counseling; assistance in applying for the California Dream Act/Financial Aid and scholarships; and providing workshops relative to DREAMers and their families. The Dream Program is located in the Student Services Center (SSC) 2nd Floor, Room 238. To make an appointment, call (310) 434-4892 or email DREAM@smc.edu.

STUDENT SUCCESS

Academic Counseling

The Counseling Department at SMC can help you with choosing and enrolling in classes, educational and career planning, navigating Corsair Connect, understanding financial aid, referrals to campus resources, and more.

Black Collegians

The Black Collegians Program/Umoja Community at SMC is designed to assist students of African descent in transferring to four-year universities and obtaining their associate degree. They offer services to help students become academically competitive and to set personal goals.

Extended Opportunity Program & Service (EOPS)

Extended Opportunity Program & Services (EOPS) at Santa Monica College is a program that supports the enrollment, retention, graduation, and transfer of students who are challenged by economic and educational disadvantages. They offer service such as academic, career, personal and transfer counseling; priority registration; supplemental textbook assistance; one-on-one tutoring; and much more.

Latino Center/Adelante

The Adelante Program is a success-oriented program focusing on academic achievement, transfer, cultural awareness, and personal growth. Adelante classes emphasize verbal, written, and critical thinking skills essential to college success. Classes accentuate the Latino experience within the context of the course subject, and most classes offer credits that are transferable to the UC and CSU systems.

Student Health Services Center

The SMC Health Services Center provides primary health care services to currently enrolled Santa Monica College students who have paid the California State mandated health fee. It focuses on health promotion, illness prevention, referrals, health and nutrition education. The staff consists of two registered nurses, a registered dietitian, two health assistants, and a nurse practitioner. The Center is located on the northeast corner of the Cayton Center Complex.

Tutoring

Free tutoring centers are available across the campus. There are dedicated centers for Business, CSIS, ESL, Math, Modern Languages, Science, and Writing & Humanities tutoring. For more information about their hours and locations, visit the SMC Tutoring Services Webpage.

Veterans Resource Center

The Veterans Resource Center at Santa Monica College serves veterans entering college for the first time or returning to college to further their education. The office acts as a liaison with the Veterans Administration verifying enrollment for students claiming benefits under the G.I. Bill or the Veterans' Vocational Rehabilitation Program. It also can also assist the veteran with referrals to various veteran-serving programs in the West Los Angeles area. If you would like additional information, please call (310) 434-8205.

STUDENT SERVICES CENTER

Located at the North end of campus on the corner of Pico and 20th street.

- Admissions & Records
- Black Collegians
- CalWORKs
- Care & Prevention Team
- Career Services Center
- Cashier's Office
- Center for Students with Disabilities
- Counseling
- Distance Education
- DREAM Program
- EOPS/CARE
- Financial Aid & Scholarships
- Guardian Scholars
- High Tech Center
- Institutional Research
- International Education Center
- Latino Center
- Pico Partnership
- Scholars Program
- Student Judicial Affairs
- Success & Engagement Center
- Transfer Counseling Center
- Welcome Center

DISCLAIMER

Some elements of the syllabus may be changed at the instructor's discretion. Students will be given at least 48 hours notice of changes whenever possible. If there is any aspect of this syllabus which you do not understand, or to which you take exception, please let the instructor know within the first week of class. Your continued attendance in this course constitutes an acknowledgement and acceptance of the requirements delineated in this syllabus.

Week #	Date (Monday)	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
1	08-28	Introduction LECTURE Chapter 12.1-12.2		LECTURE Chapter 12.3-12.4		LECTURE Chapter 12.4-12.5 EXP #1 Archimedes' Principle and Buoyancy
2	09-04	**LABOR DAY HOLIDAY**		LECTURE Chapter 12.6 Chapter 15.1-15.2		LECTURE Chapter 15.3-15.4 EXP #2 Torricelli's Equation and Equation on Continuity
3	09-11	LECTURE Chapter 15.4-15.5		LECTURE Chapter 15.6-15.7		LECTURE Chapter 15.7-15.8 EXP #3 Frequency of Transverse Standing Waves
4	09-18	LECTURE Chapter 16.1-16.2		LECTURE Chapter 16.3-16.4		LECTURE Chapter 16.5-16.6 EXP #4 The Speed of Sound (with the resonance of longitudinal waves)
5	09-25	LECTURE Chapter 16.7-16.9 DROP DEADLINE! (09/24 without W)		LECTURE Chapter 17.1-17.3		LECTURE Chapter 17.3-17.6 EXP #5 Fourier Analysis
6	10-02	**EXAM 1 CH 12, 15-16**		LECTURE Chapter 17.6-17.7		LECTURE Chapter 18.1-18.3 EXP #6 Thermal Expansion
7	10-09	LECTURE Chapter 18.4-18.5		LECTURE Chapter 18.5-18.6		LECTURE Chapter 19.1-19.2 EXP #7 Latent Heat of Fusion of Ice

8	10-16	LECTURE Chapter 19.3-19.5		LECTURE Chapter 19.6-19.7		LECTURE Chapter 19.7-19.8 EXP #8 Ratio of Heat Capacities for Air
9	10-23	**EXAM 2 CH 17-18**		LECTURE Chapter 20.1-20.2		LECTURE Chapter 20.3-20.4 EXP #9 Heat Engine
10	10-30	LECTURE Chapter 20.5-20.6		LECTURE Chapter 20.7-20.8		LECTURE Chapter 33.1-33.3 EXP #10 Entropy Statistical Interpretation
11	11-06	LECTURE Chapter 33.4-33.5		LECTURE Chapter 33.6-33.7		LECTURE Chapter 34.1-34.2 EXP #11 Pfund Refraction
12	11-13	**EXAM 3 CH 19-20**		LECTURE Chapter 34.3-34.4	DROP DEADLINE! (11/18 with W)	LECTURE Chapter 34.5-34.6 EXP #12 Curved Mirrors and Lenses
13	11-20	LECTURE Chapter 34.7-34.8		LECTURE Chapter 34 Practice Problems	**THANKSGIVING**	**NATIVE AMERICAN HERITAGE DAY**
14	11-27	LECTURE Chapter 35.1-35.2		LECTURE Chapter 35.3-35.4		LECTURE Chapter 35.4-35.5 EXP #13 Thin Film Interference
15	12-04	LECTURE Chapter 36.1-36.3		LECTURE Chapter 36.3-36.5		LECTURE Chapter 36.6-36.7 EXP #14 Diffraction
16	12-11	LECTURE Chapter 36.8 Review		**FINAL EXAM** **8–11 AM**		

17	12-19					

Self-evaluation Fall 2023 Year 2 Kevin Roberts

I have now completed 3 semesters as a full-time professor at SMC. I have learned more on how to become a better professor. I feel more confident and assured of myself when I teach my students and I want to continue to improve.

This year, after wrapping up Equitizing Gateway Courses last Spring, I joined an NSF grant for furthering racial equity lead by Silvana Carrion-Palomares and Ciaran Brewster. I have learned a lot on how connect with my Black and Latinx students. I have drawn from the best practices from them and I've rethought how I do group work and labs. I also continued to be the Astronomy club advisor. This last semester, we had some trouble getting consistent student leadership, but I'm hopeful that this upcoming semester we will have a better semester. Also, one of my students wants to start a branch of oSTEM (Out in Science, Technology, Engineering, and Math) for our queer students at SMC and I'll happily be the advisor for this club as well.

The first major change I made from the last reflection was a return to unit exams. As I said in the last reflection, I don't regret trying the chapter tests, but I now see why the bigger unit exams work better. I can emphasize the themes in a unit better, like rotations or optics. And I can have my students relax a bit, the constant patter of chapter tests increased student anxiety. I've implemented test corrections rather than curves for my exams. I want my students to learn from their mistakes. The test corrections are effectively giving my students the "boost" that they would get from a curve, but they feel more accomplished that they "earned" the points back.

The next two changes worked together, pre-lecture handouts and more think-pair-share groups. Last reflection, I noticed that most of my students didn't read the textbook before class or didn't retain much from reading the textbook. I noticed that my textbook had video resources of solved examples. Not all of them were of the highest quality, but after implementing them, the understanding of my students of the material before class started greatly increased. I didn't need to play "catch-up" with my students as much in class where I was teaching them concepts and practices for the first time. Before, it felt as though as I was laying down the tracks ahead of the train, now I had more time for planning.

Since students were more prepared before class, I increased the number of more think-pair-share groups. Last time, I noticed that many of my students didn't have much to contribute because they hadn't seen the material before class. Now, with the pre-lecture notes they completed before class, I saw more connections between my students. I have had to make some announcement to the class to make sure that all voices were heard in the discussions though. I didn't want to just "get the right answer." I don't have as much time in class for examples I do, but I think it's a worthy trade-off.

On that note, I'd say the biggest improvement I could make is time management. As my evaluators recommended, having set rhythms to my classes with generally improve my students learning. I won't have to be rushing to complete examples or cover lab material. This structure will help me as well stay on-target with the topics I want to cover in each class and the theming of each class material. On that note, I will take just Jenn and Emin suggestion that I work with them to develop time management schedules: somewhat flexible repeating patterns of introducing a topic, a couple of examples, then think-pair-share, and specifically stopping

lecture at a set time, no matter where I am, so that the students have ample time to complete their labs.

I am very happy with all that I learned over the semesters, and I look forward to learning and growing more in the coming semesters!

Kevin Roberts

Exam 1
Physics 21

Chapters 1 – 3

Name:

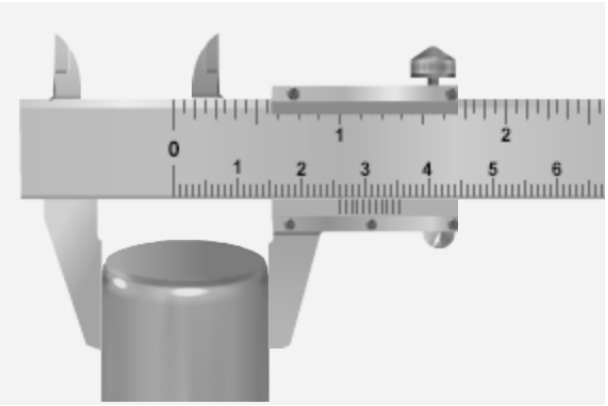
_____

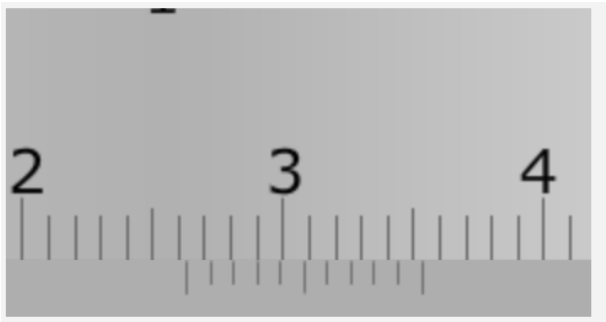
Your test has 5 problems, each worth 20 points.

1. Consider the measurements of a circular cylinder using vernier calipers and a triple beam balance. (Diagrams on next page)
    a. What are the measurements for the diameter, length, and mass (include uncertainties)
    b. Find the volume of the cylinder.
    c. Find the mass of the cylinder.
    d. The density of the cylinder.

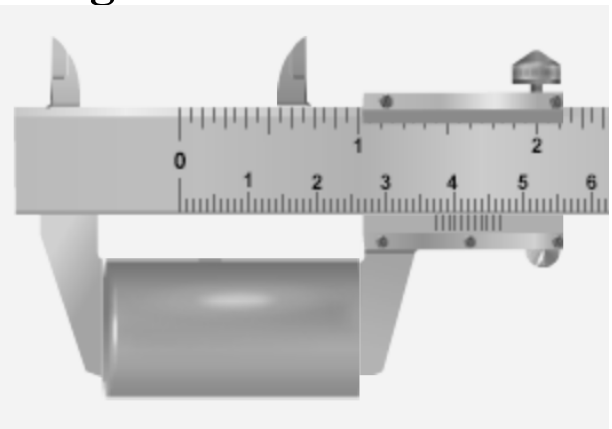
Make sure to propagate uncertainty for the derived values in (b), (c), and (d) (like in the lab) and round to the correct number of significant figures.

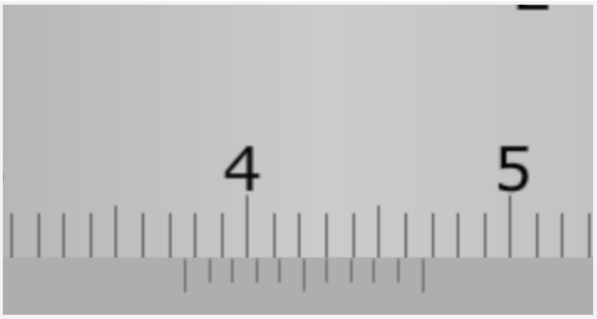
Diameter:



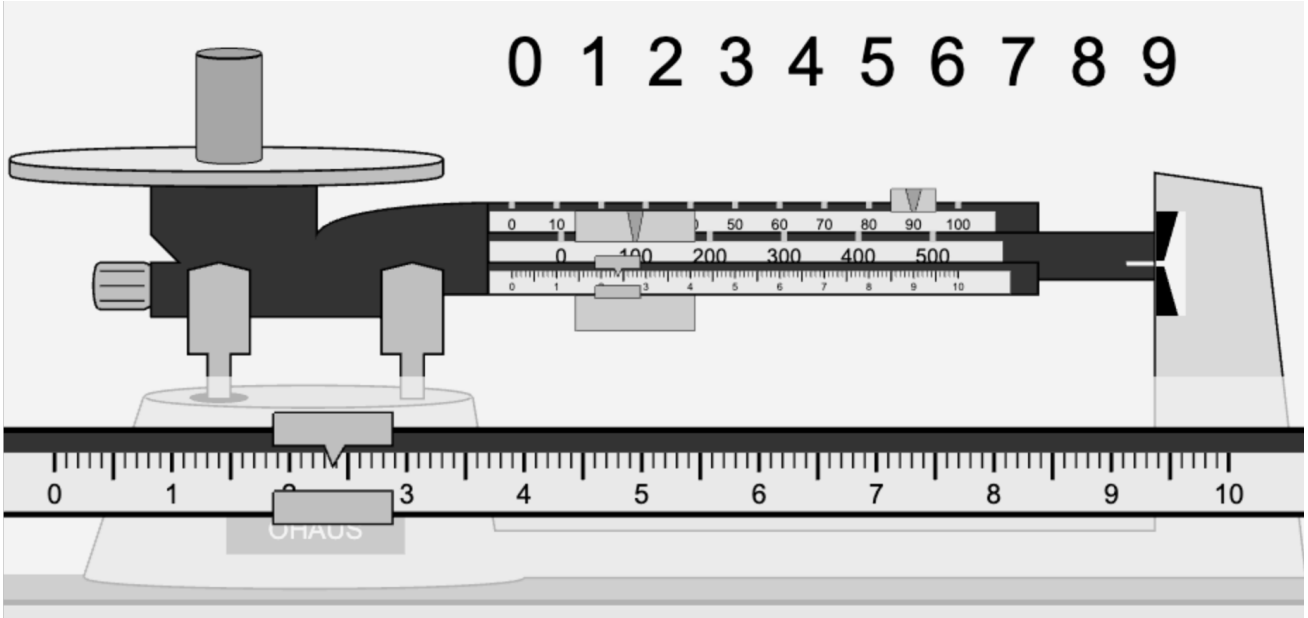


Length:



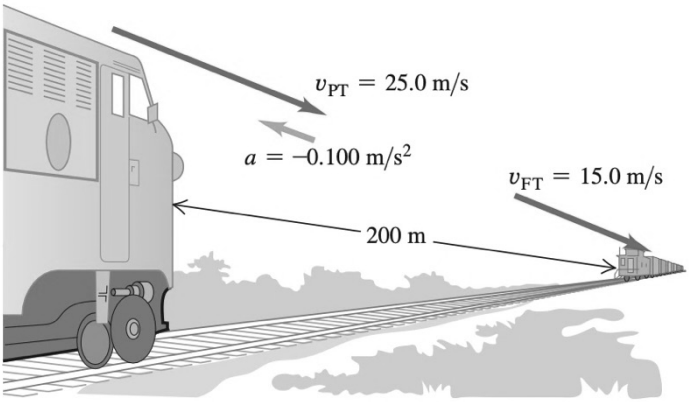


Mass



2. A spelunker is surveying a cave. She follows a passage 180 m straight west, then 210 m in a direction 45° east of south, and then 280 m at 30° east of north. After a fourth displacement, she finds herself back where she started. Use the method of components to determine the magnitude and direction of the fourth displacement in the following steps.
    a. Draw a vector diagram representing the exploration so far, using the tip-to-tail or parallelogram method. Give each displacement vector a name.
    b. Draw a coordinate axis to represent North, South, East, and West.
    c. break each vector into components along that coordinate axis.
    d. What is the spelunker's total displacement from their starting point in components (before the fourth displacement)?
    e. To return to the starting point, the spelunker travels _____ m away at an angle of _____ measured from east.

3. The engineer of a passenger train traveling at 25.0 m/s sights a freight train whose caboose is 200 m ahead on the same track. The freight train is traveling at 15.0 m/s in the same direction as the passenger train. The engineer of the passenger train immediately applies the brakes, causing a constant acceleration of 0.100 m/s^2 in a direction opposite to the train's velocity, while the freight train continues with constant speed. Take $x = 0$ m at the location of the front of the passenger train when the engineer applies the brakes.



   a. Will the cows nearby witness a collision?
   b. If so, where will it take place?
   c. On a single graph, sketch the positions of the front of the passenger train and the back of the freight train.

Find these in the following steps:

   i. Draw a clear motion diagram illustrating the problem.
   ii. Draw a coordinate system, with a clearly marked origin.
   iii. Identify and number the moments of interest (make sure to draw any vectors that are constant on the side)
   iv. Write the kinematic variables for each moment of interest and fill in the known kinematic variables.
   v. Write down the equations you will use to solve the equation for the unknown variables.
   vi. Solve the equations via algebra (do NOT plug in numbers for a variable unless that number is zero)

Use the back of this page to do your work.

Workspace for problem 3.

4. An airplane pilot sets a compass course due west and maintains an airspeed of 220 km/h. After flying for 0.500 h, she finds herself over a town 120 km west and 20 km south of her starting point. Find the wind velocity (magnitude and direction).

Find these in the following steps:

i. Draw a diagram of the plane, air, and Earth.
ii. Clearly identify the velocity vectors and **the frame they are measured in.**
iii. Find the target variable.
iv. Set-up the equation(s) and/or tables you need to solve.

(Hint: the vectors DON'T form a right triangle)

5. During a storm, a car traveling on a level horizontal road comes upon a bridge that has washed out. The driver must get to the other side, so he decides to try leaping the river with his car. The side of the road the car is on is 21.3 m above the river, while the opposite side is only 1.8 m above the river. The river itself is a raging torrent 48.0 m wide.
    a. How fast should the car be traveling at the time it leaves the road in order just to clear the river and land safely on the opposite side?
    b. What is the speed of the car just before it lands on the other side?
       Find these in the following steps:
        i. Draw a clear motion diagram illustrating the problem.
        ii. Draw a coordinate system, with a clearly marked origin.
        iii. Identify and number the moments of interest (make sure to draw any vectors that are constant on the side).
        iv. Write the kinematic variables for each moment of interest and fill in the known kinematic variables.
        v. Write down the equations you will use to solve the equation for the unknown variables.
        vi. Solve the equations via algebra (do NOT plug in numbers for a variable unless that number is zero).

Extra Space/Scratch work

CONCEPT: INTRODUCTION TO UNITS AND THE S.I. SYSTEM

- Physics = study of natural phenomena, which includes lots of measurements & equations! Physics = Math + Rules
  - In nature, we measure **physical quantities** (*mass, length…*), which must have _____ & _____
  (*Example: You measure the mass of a box*)

_____ _____
[Number] **[Unit]**

- For physics equations to work, ALL units in it must be _____ with each other.
  - Groups of compatible units that "work together" form a _____ of units.
  - In Physics, *always* use S.I. units (*Système International*)

Quantity	S.I.	Imperial
MASS	Kilogram [ ]	Pound [lb]
LENGTH	Meter [ ]	Foot [ft]
TIME	Second [ ]	Second [s]
FORCE	Newton [ ]	Foot-pound

Force = Mass × Acceleration

$$F = m \times a$$

[ ] = [ ] × [ ] → [COMPATIBLE | INCOMPATIBLE]

[ ] = [ ] × [ ] → [COMPATIBLE | INCOMPATIBLE]

CONCEPT: METRIC PREFIXES

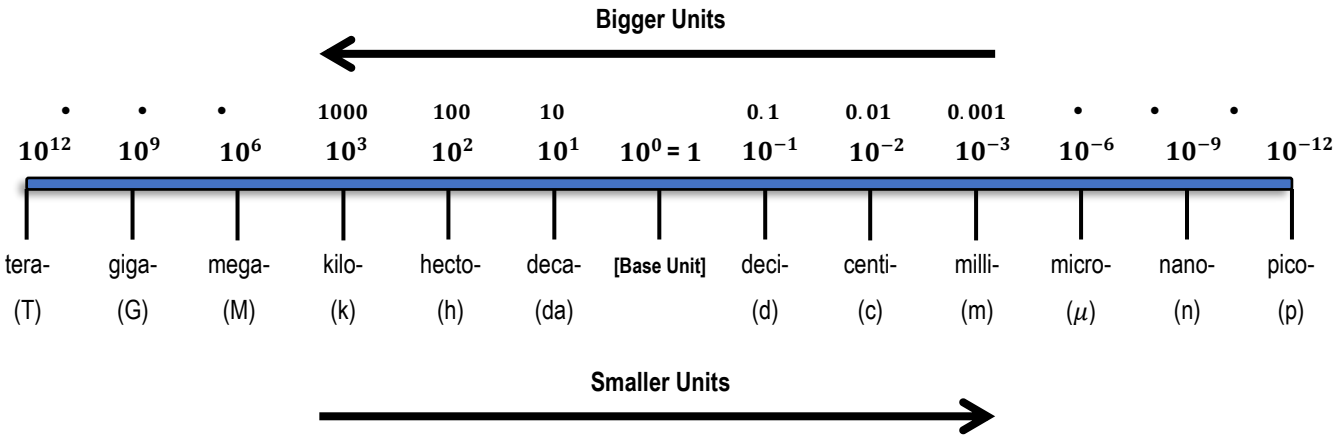
[Base Unit] [Prefixes]

- A metric prefix is a **letter** or **symbol** that goes before a base unit: m, g, s → **k**m, ,**m**g, **μ**s,

  - Each letter / prefix stands for a specific power of 10 multiplied by the base unit.

  Example: 5 km = _____ m = _____ m

  4.6 ms = _____ s = _____ s



EXAMPLE: Express the following measurements using the desired prefix.

STEPS
1) Identify starting & target prefixes
2) Move from start → target, count # of exponents moved
3) Shift decimal place in the same direction moved in Step 2

a) 6.5 hm to m

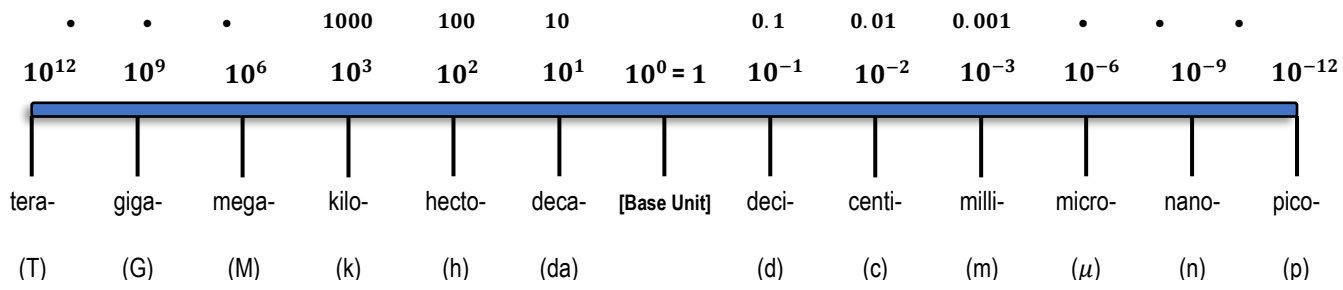
b) 3.89 mm to m

c) 7.62 kg to μg

- When re-writing numbers with metric prefixes,
  - Shifting from a ***bigger*** to ***smaller*** unit, number becomes **[LARGER | SMALLER]**
  - Shifting from a ***smaller*** to ***bigger*** unit, number becomes **[LARGER | SMALLER]**

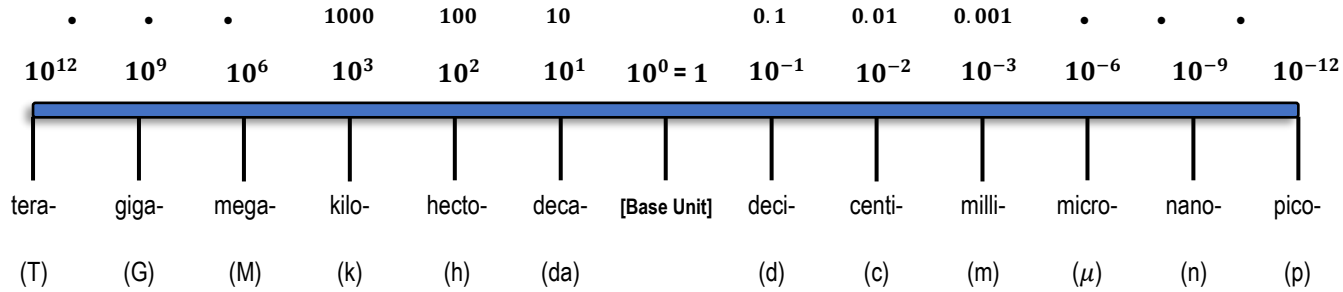
PRACTICE**:** The earth's circumference is approximately 40.1 Mm (megameters)**.** What is this circumference in kilometers?

A) 0.0401 km
B) 40,100,000 km
C) 40,100 km
D) 0.00401 km



PRACTICE**:** Astronomers often detect radio waves with wavelengths of 3,000,000,000 nm**.** What is this wavelength expressed in decameters (dam)?

A) 3 dam
B) 0.3 dam
C) 30 dam
D) 0.03 dam



CONCEPT: SCIENTIFIC NOTATION

- We use **Scientific Notation** to _____ very LONG, inconvenient numbers into SHORTER ones.

Mass of Earth = 5,972,000,000,000,000,000,000,000 kg

= _____

General Format for Scientific Notation

$$\underbrace{A.BC}_{[\,\#\,\geq\,___\ \text{but}\ <\ ___\,]} \times 10^{D}$$

[# ≥ ___ but < ___] [_____]

STANDARD FORM → SCIENTIFIC NOTATION

a) 304,605.27 kg

b) 0.000102 m

c) 7 s

Standard Form → Scientific Notation

1) Move decimal to get # ≥ 1 but < 10

2) Round long numbers with many non-zero numbers to 2 decimal places

3) # of decimal places moved = Exponent
- If original number > 10, exponent is **+**
- If original number < 1, exponent is **–**

SCIENTIFIC NOTATION → STANDARD FORM

a) 5.45×10^{8} kg

b) 9.62×10^{-5} s

Scientific Notation → Standard Form

1) Exponent = # of decimal places moved
- If exponent is **+**, number becomes ***larger***
- If exponent is **–**, number becomes ***smaller***

PRACTICE: Rewrite 0.00016 kg in scientific notation.

A) 1.6×10^{-4} kg
B) 16×10^{-3} kg
C) 1.6×10^{4} kg
D) 1.6×10^{-3} kg

PRACTICE: Rewrite 299,800,000 m/s in scientific notation.

A) 2.998×10^{5} m/s
B) 3.00×10^{8} m/s
C) 3.00×10^{5} m/s
D) 2.998×10^{-8} m/s

EXAMPLE: Express 0.0000529×10^{-6} m in scientific notation.

PRACTICE: Rewrite 3.41×10^{-4} in standard form:

A) 0.000341
B) 34,100
C) 0.0000341
D) 3,410

PRACTICE: Rewrite 9.98×10^{7} in standard form.

A) 0.000000998
B) 0.0000000998
C) 9,980,000,000
D) 99,800,000

CONCEPT: UNIT CONVERSIONS

- You'll often see non-**S.I.** units in problems, so you MUST _____ them to **S.I.** units before using equations!

EXAMPLE: Convert 22 **lbs** into **kg.**

____ [ ] × (_____) × (_____) = ____ [ ]

(_____) (_____) (_____)

Quantity	Conversion Factors / Ratios		
MASS	1 kg = 2.2 lbs	1 lb = 450 g	1 oz = 28.4 g
LENGTH	1 km = 0.621 mi	1 ft = 0.305 m	1 in = 2.54 cm
VOLUME	1 gal = 3.79 L	1 mL = 1 cm³	1 L = 1.06 qt

STEPS FOR CONVERTING UNITS

1) Write **Given, Target** units

2) Write **Conversion Factors / Ratios** as _____

- Write fractions to cancel out _____ units with _____ units

3) Multiply all **#s** on top, all **#s** on bottom, and solve

EXAMPLE: Convert the following measurements to the desired units.

a) 67.5 **mi/hr** to **m/s**

____ [ ] × (_____) × (_____) × (_____) = ____ [ ]

b) 100 **ft²** to **m²**

____ [ ] × (_____) × (_____) = ____ [ ]

- When converting units with exponents, multiply conversion factors as many times as the # in the exponent.

PRACTICE: Convert 850 ft to km.

A) 259 km
B) 0.259 km
C) 2.79×10^6 km
D) 2.79 km

Quantity	Conversion Factors / Ratios		
MASS	1 kg = 2.2 lbs	1 lb = 450 g	1 oz = 28.4 g
LENGTH	1 km = 0.621 mi	1 ft = 0.305 m	1 in = 2.54 cm
VOLUME	1 gal = 3.79 L	1 mL = 1 cm³	1 L = 1.06 qt

PRACTICE: The speed of light is approximately 3.00×10^8 m/s. Convert this speed to yards/week (yd/wk).

A) 1.84×10^{13} yd/wk
B) 1.98×10^{14} yd/wk
C) 1.78×10^{15} yd/wk
D) 1.8×10^{7} yd/wk

Quantity	Conversion Factors / Ratios		
MASS	1 kg = 2.2 lbs	1 lb = 450 g	1 oz = 28.4 g
LENGTH	1 km = 0.621 mi	1 ft = 0.305 m	1 in = 2.54 cm
VOLUME	1 gal = 3.79 L	1 mL = 1 cm³	1 L = 1.06 qt

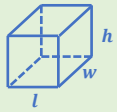
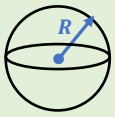
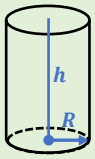
PRACTICE**:** How many gallons are in 1 cubic meter **(**m^3**)**?

Quantity	Conversion Factors / Ratios		
MASS	1 kg = 2.2 lbs	1 lb = 450 g	1 oz = 28.4 g
LENGTH	1 km = 0.621 mi	1 ft = 0.305 m	1 in = 2.54 cm
VOLUME	1 gal = 3.79 L	1 mL = 1 cm^3	1 L = 1.06 qt

CONCEPT: SOLVING DENSITY PROBLEMS

- Density is defined as _____ divided by _____ ⇒ $\boxed{\rho = \text{———}}$ **[Units: ———]**
  (amount of stuff) (amount of space taken up)

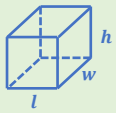
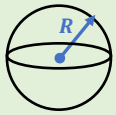
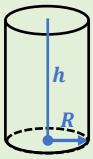
  - Many problems involve relating density, mass, and volume of **geometric shapes,** and converting units**.**

RECTANGULAR PRISM	SPHERE	CYLINDER
		
$V = l \times w \times h$	$V = \frac{4}{3}\pi R^3$	$V = \pi R^2 h$

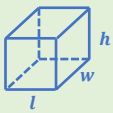
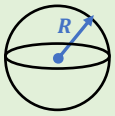
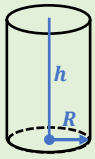
EXAMPLE**:** The average density of Earth is 5500 kg/m^3**.** If we assume it is approximately a sphere with a radius of 3960mi, what is the mass of Earth? (1 mi ≈ 1609 m)

PRACTICE: A wooden cylinder has a radius of 3.5 cm and a height of 6 cm. If the mass is 161 g, what is the density of the wooden cylinder?

A) 222 kg/m^3
B) 3.767×10^3 kg/m^3
C) 700 kg/m^3
D) 2440 kg/m^3

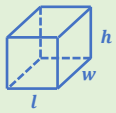
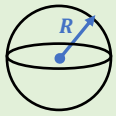
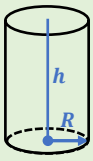
RECTANGULAR PRISM	SPHERE	CYLINDER
		
$V = l \times w \times h$	$V = \frac{4}{3}\pi R^3$	$V = \pi R^2 h$

EXAMPLE: An iron cube has a mass of 0.515 kg. The density of iron is 7.87×10^3 kg/m^3. What is the length of the sides of the cube?

RECTANGULAR PRISM	SPHERE	CYLINDER
		
$V = l \times w \times h$	$V = \frac{4}{3}\pi R^3$	$V = \pi R^2 h$

PRACTICE**:** Copper has a density of 8.96 g/cm^3**.** If a single copper atom as a mass of 1.055×10^{-25} kg, what is the volume of a copper atom?

A) 1.18×10^{-26} m^3
B) 9.45×10^{-25} m^3
C) 1.18×10^{-29} m^3
D) 1.18×10^{-26} cm^3

RECTANGULAR PRISM	SPHERE	CYLINDER
		
$V = l \times w \times h$	$V = \frac{4}{3}\pi R^3$	$V = \pi R^2 h$

CONCEPT: DIMENSIONAL ANALYSIS

- Equations work only if they are *dimensionally consistent*, meaning the units on both sides are _____.
  - Easy way to check if equations make sense ***without*** calculations.

EXAMPLE: You walk a constant speed v = 5m/s for a time **t** of 2s. Which equation from below would be appropriate for determining the distance **d** in meters?

Distance = speed × time

$$d = v \times t$$

[ ] = [ ] × [ ]

OR

Distance = speed × time²

$$d = v \times 2\,t^2$$

[ ] = [ ] × [ ]

DIMENSIONAL CONSISTENCY

1) Replace variables with units
2) Ignore – signs & numbers (2, ½, etc..)
3) Multiply & divide to cancel out units
4) Check if units on left = units on right

[CONSISTENT | INCONSISTENT] [CONSISTENT | INCONSISTENT]

DETERMINING UNITS OF UNKOWN VARIABLES

- You'll also need Dimensional Analysis to figure out the units of unknown variables.

EXAMPLE: Hooke's Law states that a restoring Force **F**, measured in Newtons [N], in springs is related to the distance from equilibrium **x** by the equation **F = −kx.** What are the units of the force constant **k**?

SOLVING UNITS OF VARIABLES

1) Replace variables with units
2) Ignore – signs & numbers (2, ½, etc..)
3) Isolate unknown variable
4) Solve

PRACTICE: A box moving with an initial speed **v** is accelerated horizontally. If **x** is measured in [m], **v** in [m/s], **a** in [m/s^2], **t** in [s] which of the following equations is correct for solving the distance **x**?

A) $x = \frac{a}{t^2}$
B) $x = v + \frac{1}{2} at$
C) $x = vt + \frac{1}{2} at^2$

PRACTICE: Newton's Law of Gravitation describes the attraction force between two masses. The equation is $\boldsymbol{F = G\frac{m_1 m_2}{r^2}}$, where F is in [$\frac{\mathbf{kg \cdot m}}{\mathbf{s^2}}$], $\boldsymbol{m_1}$ and $\boldsymbol{m_2}$ are masses in [**kg**], and ***r*** is the distance in [**m**] between them.

Determine the units of the Universal Constant ***G***.

A) $\frac{kg \cdot s^2}{m^3}$

B) $\frac{m^3}{kg \cdot s^2}$

C) $\frac{m}{s^2}$

D) $\frac{m^3}{s^2}$

CONCEPT: COUNTING SIGNIFICANT FIGURES (SIG FIGS)

● In Physics, measurements have **PRECISION**, indicated by the # of digits:

10 kg	10.27 kg
[LESS | MORE] precision	**[LESS | MORE]** precision

● Not ***all*** digits in measurements matter. Significant Figures are the # of digits that _____.

15 kg	015 kg
# digits given: _____	# digits given: _____
# digits that matter: _____	# digits that matter: _____

EXAMPLE: Determine the number of significant figures in the number below:

0.013200972000

_____ 0s _____ 0s _____ 0s

# of Significant Figures: _____

STEPS
1) Eliminate Leading 0's
2) If # has no decimal, eliminate Trailing 0's
3) Count remaining digits - *Never* eliminate non-zeroes or Middle 0's

EXAMPLE: How many significant figures are there in each of the following numbers?

a) 100.00 **b)** 0.0043 **c)** 31000092

d) 100 **e)** 73917000 **f)** 0.00900

PRACTICE**:** How many significant figures are in each of the following numbers?

a) 0.0032 **b)** 10790 **c)** 08.02

CONCEPT: MATH WITH SIGNIFICANT FIGURES

- When doing math to calculate values, there are additional rules to determine # of Sig Figs:

IF + | – *only*,	Round answer to same **[Sig Figs | Decimal Places]** as # with *least* **[Sig Figs | Decimal Places]**
IF × | ÷ *only*,	Round answer to same **[Sig Figs | Decimal Places]** as # with *least* **[Sig Figs | Decimal Places]**
IF + | – *and* **× | ÷,**	Use P→E→MD→AS and round answer to the *most* # of **[Sig Figs | Decimal Places]**

EXAMPLE: Write the answer for the following calculations below, expressed in the appropriate # of Sig Figs:

a) 2.56 + 6.2901

b) 5.389 – 4.3 + 0.103

c) 43.5287 ÷ 0.05192 × 0.0023

d) 123.57 × 0.031 + 4.68

PRACTICE**:** What is the area of a sidewalk that is 2.293 m wide and 90 m long? Write your answer with the correct number of significant figures**.**

A) 206.4 m^2
B) 210 m^2
C) 206.37 m^2
D) 200 m^2

EXAMPLE**:** Block A has side lengths 0.50 m × 0.875 m × 2.250 m**.** Block B has a volume of 2.6 m^3**.** What is the combined volume of the blocks, expressed with the correct number of significant figures?

CONCEPT: INTRODUCTION TO VECTORS AND SCALARS

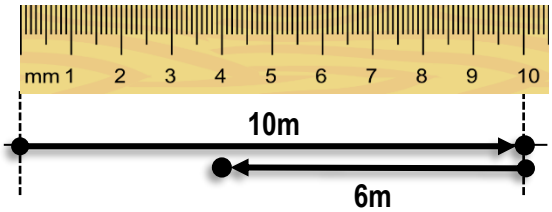
- When we take measurements, you always get the _____ (size of measurement). [*Example*: ***60°F, 10kg***]
  - SOME measurements *also* have _____. [*Example*: ***10m right, 20 miles/hr NORTH***]
  - Measurements *with* direction are **[Vectors | Scalars];** measurements *without* direction are **[Vectors | Scalars]**

Measurement	**Quantity**	Magnitude?	Direction?	Vector/Scalar
"Apple weighs 5kg"	Mass			**[Vector | Scalar]**
"Days are 24hr long"	Time			**[Vector | Scalar]**
"It's 60°F outside"	Temperature			**[Vector | Scalar]**
"I pushed with 100N left"	Force			**[Vector | Scalar]**
"I walked for 10 ft"				**[Vector | Scalar]**
"I walked 10 ft. east"				**[Vector | Scalar]**
"I drove at 80 mph"				**[Vector | Scalar]**
"I drove 80mph west"				**[Vector | Scalar]**

CONCEPT: DISPLACEMENT VS. DISTANCE

● There are two similar-sounding words to measure **how FAR** something moves (Length):

DISTANCE (d)

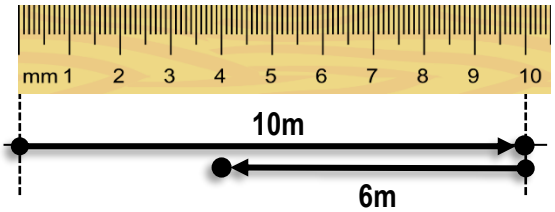


- _____ of all lengths traveled

$d =$ _____ → **Scalar (Magnitude *only*)**

_____ = _____

DISPLACEMENT ($\Delta\vec{x}$)

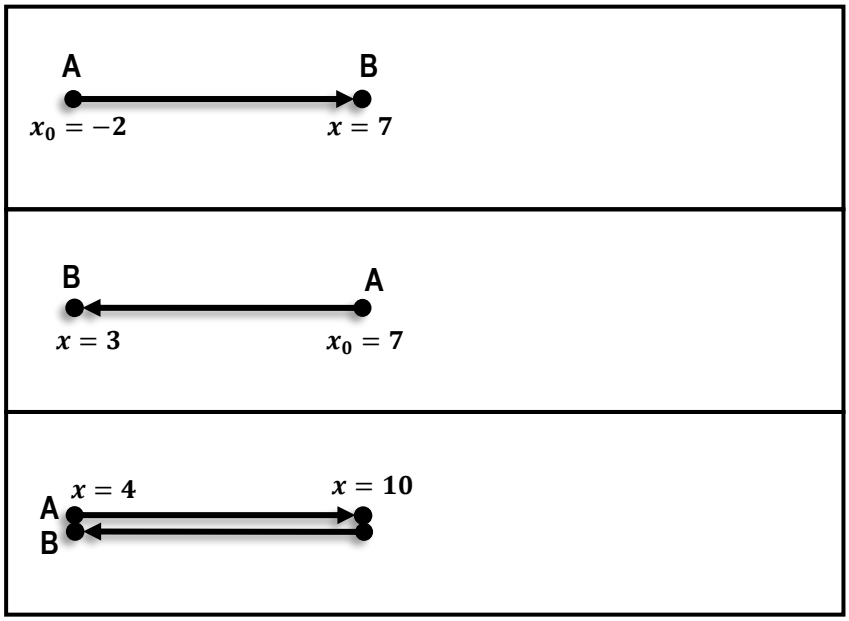


- _____ in position (___)
- _____ between initial & final position

$\Delta x =$ _____ → **Vector (Mag. + Dir.)**

_____ = _____

EXAMPLE: Find the displacement and total distance traveled from **A** to **B** for each of the following situations:



● Displacements can sometimes be negative, but distances are *ALWAYS* positive.

- In Physics, **(+ / –)** signs are usually used to indicate direction!

PRACTICE**:** Starting from a pillar, you run 140m east (the +x-direction), then turn around**. (a)** How far west would you have to walk so that your total distance traveled is 300m? **(b)** What is the magnitude and direction of your total displacement?

CONCEPT: INTRO TO VECTOR MATH

- Adding/subtracting scalars is easy. But vectors have *direction*, so math with vectors is sometimes not as straightforward.
  - Because vectors have direction, they're drawn as _____.

COMBINING SCALARS

"You combine a 3kg & 4kg box"

Total Mass: 3kg + 4kg = _____

- Simple Addition

COMBINING PARALLEL VECTORS

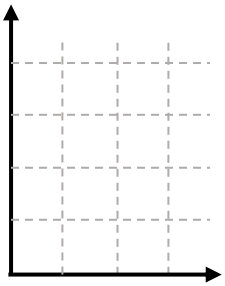
"You walk 3m right, then 4m right"

Total Displacement: _____

- Add just like normal numbers

COMBINING PERPENDICULAR VECTORS

"You walk 3m right, then 4m up"



Total Displacement: _____

- Forms _____.
  - just **TRIANGLE MATH**

EXAMPLE: For each of the following situations, draw your displacement vectors and calculate the total displacement:

(a) You walk 10m to the right, and then 6m to the left

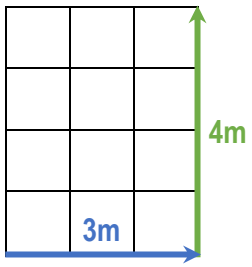
(b) You walk 6m to the right, and then 8m down

PRACTICE: Two perpendicular forces act on a box, one pushing to the right and one pushing up. An instrument tells you the magnitude of the total force is 13N. You measure the force pushing to the right is 12N. Calculate the force pushing up.

CONCEPT: ADDING VECTORS GRAPHICALLY

- Vectors are drawn as arrows and are added by _____ the arrows (tip-to-tail).

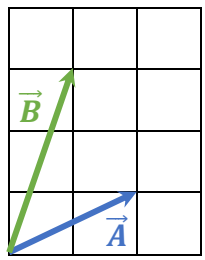
ADDING PERPENDICULAR VECTORS



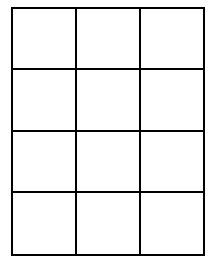
Resultant Vector:
(Total Displacement)

_____

ADDING ANY VECTORS

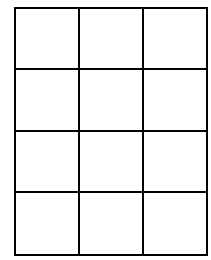


$\vec{A} + \vec{B}$



$\Leftrightarrow$

$\vec{B} + \vec{A}$



Resultant Vector:
(Total Displacement)

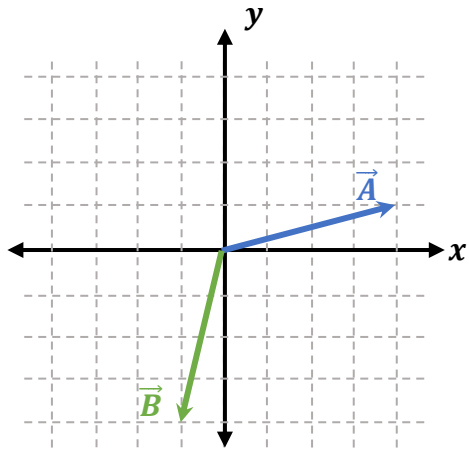
_____

Resultant Vector:
(Total Displacement)

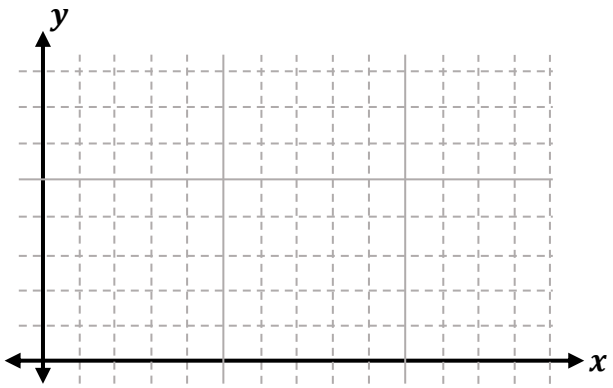
_____

- The **RESULTANT** vector ($\vec{C}$ or $\vec{R}$) is *always* the **SHORTEST PATH** from the **start** of the first vector → **end** of the last.
  - Adding vectors does **NOT** depend on the order (commutative), so $\vec{A} + \vec{B} = \vec{B} + \vec{A}$.

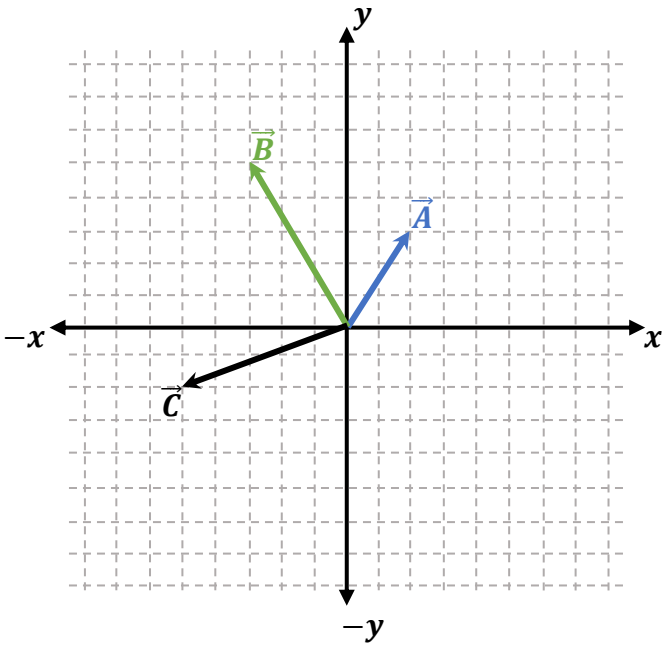
EXAMPLE: Find the magnitude of the Resultant Vector $\vec{C} = \vec{A} + \vec{B}$.



PRACTICE**:** A delivery truck travels 8 miles in the +x-direction, 5 miles in the +y-direction, and 4 miles again in the +x-direction**.** What is the magnitude (in miles) of its final displacement from the origin?



EXAMPLE: Find the magnitude of the Resultant Vector $\vec{D} = \vec{A} + \vec{B} + \vec{C}$.

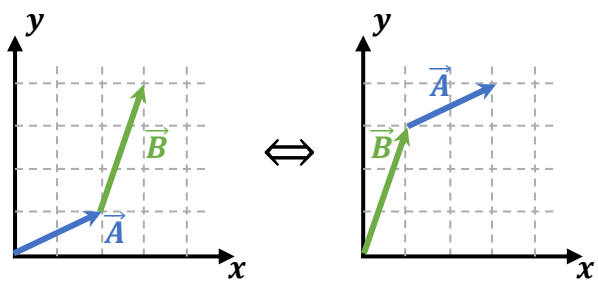


CONCEPT: SUBTRACTING VECTORS GRAPHICALLY

- Subtracting vectors is *exactly* like adding vectors tip-to-tail, but one (or more) of the vectors gets _____.

ADDING VECTORS

$\vec{A} + \vec{B}$ $\qquad$ $\vec{B} + \vec{A}$



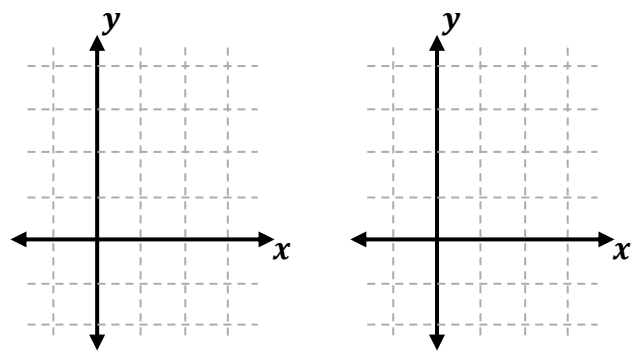
Resultant → shortest path:
(Total Displacement)

_____

- When adding, order **[DOES | DOES NOT]** matter

SUBTRACTING VECTORS

$\vec{A} - \vec{B}$ $\qquad$ $\vec{B} - \vec{A}$



Resultant → shortest path:
(Total Displacement)

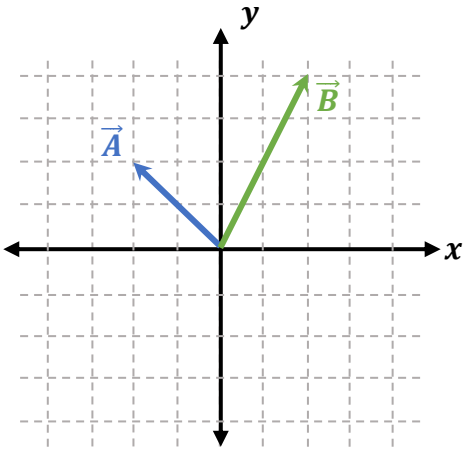
_____

Resultant → shortest path:
(Total Displacement)

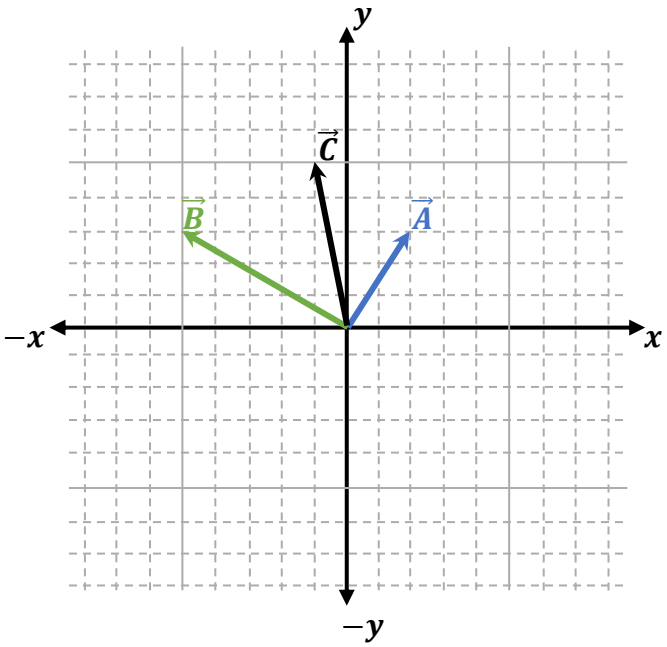
_____

- "Negative" vector: SAME magnitude, _____ direction
- When subtracting, order **[DOES | DOES NOT]** matter

EXAMPLE: Find the magnitude of the Resultant Vector $\vec{C} = \vec{A} - \vec{B}$.



PRACTICE: Find the magnitude of the Resultant Vector $\vec{D} = \vec{C} - \vec{B} - \vec{A}$.

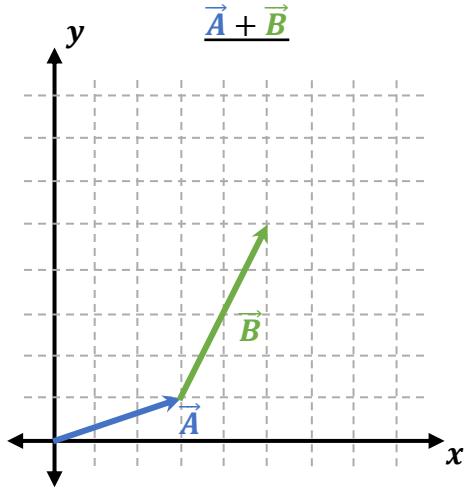


CONCEPT: ADDING MULTIPLES OF VECTORS

- When you multiply a vector by a number ($\vec{A} \rightarrow 2\vec{A}$), the **magnitude** (length) changes but NOT the direction.

ADDING VECTORS

$\vec{A} + \vec{B}$

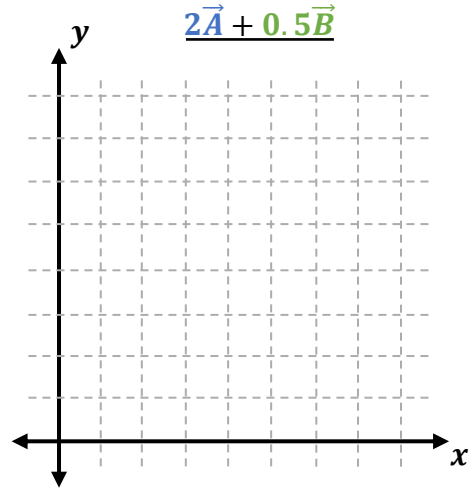


Resultant Vector → Shortest Path:
(Total Displacement)

_____

ADDING MULTIPLES OF VECTORS

$2\vec{A} + 0.5\vec{B}$

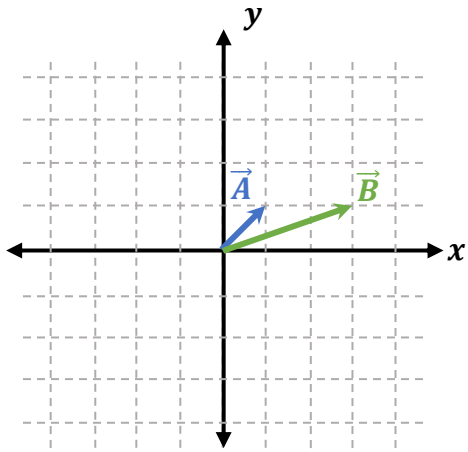


Resultant Vector → Shortest Path:
(Total Displacement)

_____

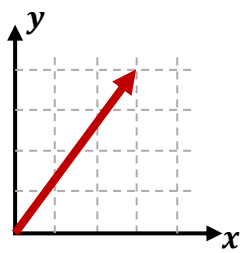
- Multiplying by > 1 **[increases | decreases]** magnitude/length
- Multiplying by < 1 **[increases | decreases]** magnitude/length

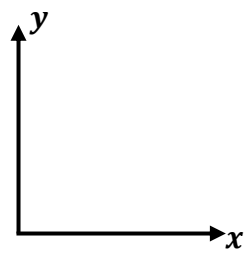
EXAMPLE: Find the magnitude of the Resultant Vector $\vec{C} = 3\vec{A} - 2\vec{B}$.



CONCEPT: VECTOR COMPOSITION AND DECOMPOSITION

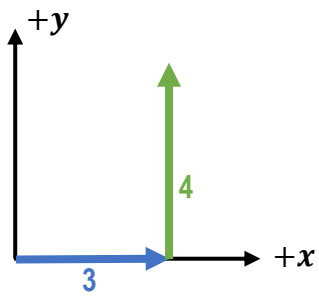
- You'll need to do vector math ***without*** using grids/ squares.
  - Vectors have **magnitude** (length), **direction** (angle $\boldsymbol{\theta_x}$), and **components** (legs).





VECTOR COMPOSITION

1D Components → 2D Vector (Magnitude & Direction)

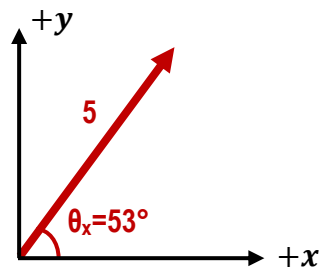


- Components A_x & A_y combine → magnitude $\vec{A}$
  - Points in direction $\boldsymbol{\theta_x}$

VECTOR COMPOSITION
$A = \sqrt{A_x^2 + A_y^2}$
$\theta_x =$ _____

VECTOR DECOMPOSITION

2D Vector (Magnitude & Direction) → 1D Components



- Use **SOH-CAH-TOA** to decompose $\vec{A}$ →components A_x & A_y.
  - Angle $\boldsymbol{\theta_x}$ *must* be drawn to nearest _____

VECTOR DECOMPOSITION
$A_x =$ _____
$A_y =$ _____

EXAMPLE: For each of the following, draw the vector and solve for the missing variable(s).

a) A_x = 8m, A_y = 6m, $\boldsymbol{A}$ = ? $\boldsymbol{\theta_x}$ = ?

b) B = 13m, $\boldsymbol{\theta_x}$ = 67.4°, B_x = ? B_y = ?

EXAMPLE**:** A vector **A** has y-component of 12 m makes an angle of 67.4° with the positive x-axis**. (a)** Find the magnitude of **A. (b)** Find the x-component of the vector**.**

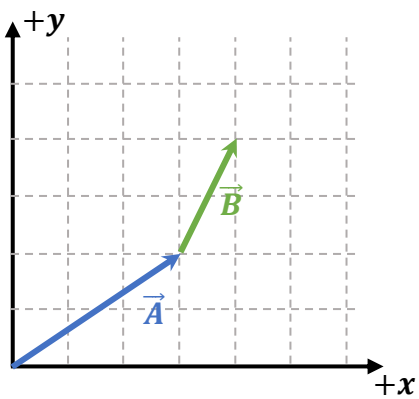
Vector Composition (Components→Vector)	Vector Decomposition (Vector→Components)
$A = \sqrt{A_x^2 + A_y^2}$ $\theta_X = \tan^{-1}\left(\frac{A_y}{A_x}\right)$	$A_x = A\cos(\theta_X)$ $A_y = A\sin(\theta_X)$

CONCEPT: VECTOR ADDITION BY COMPONENTS

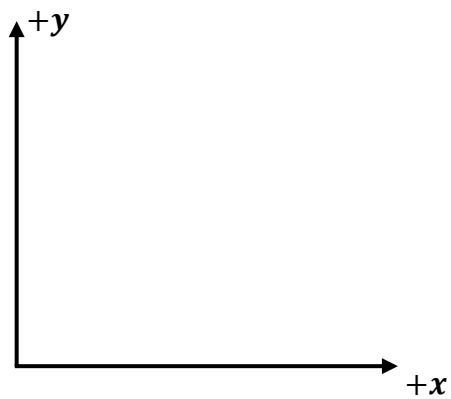
- You'll need to add vectors together and calculate the magnitude & direction of the resultant *without* counting squares.

EXAMPLE: You walk 5m at 53° above the +x-axis, then 8m at 30° above the +x-axis. Calculate the magnitude & direction of your total displacement.

ADDING VECTORS GRAPHICALLY (WITH SQUARES)



ADDING VECTORS BY COMPONENTS (WITHOUT SQUARES)



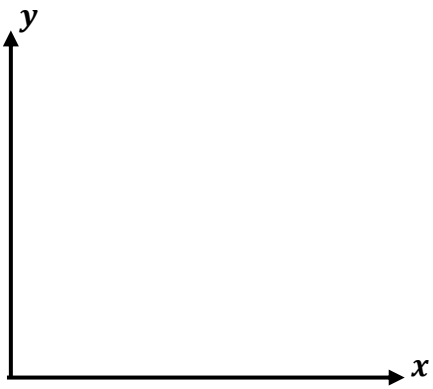
	x	y
$\vec{A}$		
$\vec{B}$		
$\vec{R}$ = _____		

VECTOR ADDITION

1) Draw & connect vectors tip-to-tail
2) Draw Resultant & components
3) Calculate ALL X&Y components
4) Combine X & Y components according to R equation
5) Calculate R and θ_R

Vector Composition (Components→Vector)	Vector Decomposition (Vector→Components)
$R = \sqrt{R_x^2 + R_y^2}$ $\theta_X = \tan^{-1}\left(\frac{R_y}{R_x}\right)$	$A_x = A\cos(\theta_X)$ $A_y = A\sin(\theta_X)$

EXAMPLE: Vector $\vec{A}$ has a magnitude of 10m at a direction 40° above the +x-axis. $\vec{B}$ has magnitude 3 at a direction 20° above the x-axis. Calculate the magnitude and direction of $\vec{R} = \vec{A} - 2\vec{B}$.

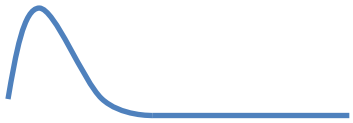


VECTOR ADDITION
1) Draw & connect vectors tip-to-tail
2) Draw Resultant & components
3) Calculate ALL X&Y components
4) Combine X & Y components according to R equation
5) Calculate R and θ_R

Vector Composition (Components→Vector)	Vector Decomposition (Vector→Components)
$R = \sqrt{R_x^2 + R_y^2}$ $\theta_X = \tan^{-1}\left(\frac{R_y}{R_x}\right)$	$A_x = A\cos(\theta_X)$ $A_y = A\sin(\theta_X)$

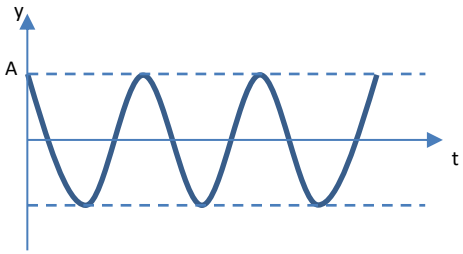
CONCEPT: WHAT IS A WAVE?

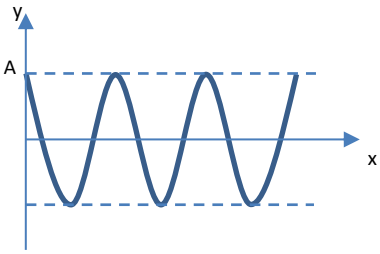
- A WAVE is a moving disturbance (oscillation) that carries energy.
  - A common example is a wave on a string, where the moving string carries _____ energy



- We're only going to focus on PERIODIC waves, which are waves with _____ cycles
  - A CYCLE is defined as a portion of the motion that begins and ends in the same state

- A wave has several important characteristics:
  - PERIOD: the amount of _____ per cycle
  - FREQUENCY: number of _____ per unit _____
  - WAVELENGTH: the _____ the wave travels in a cycle
  - SPEED





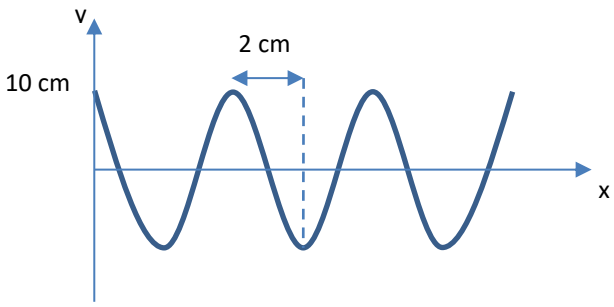
- The WAVELENGTH and PERIOD are related to each other by the SPEED of the wave:

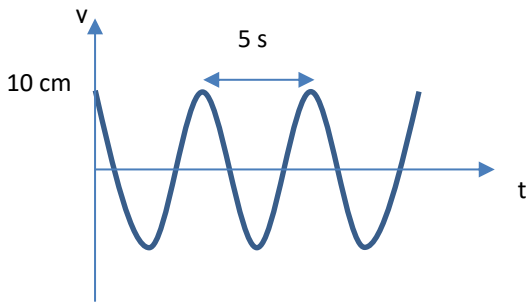
$v =$ _____ $=$ _____ with $f =$ _____

EXAMPLE: A wave has a speed of 12 m/s and a wavelength of 5 m. What is the frequency of the wave? The period?

EXAMPLE: PROPERTIES OF A WAVE FROM GRAPHS

What are the properties of the following wave (wavelength, period, frequency and speed) given in the graphs?



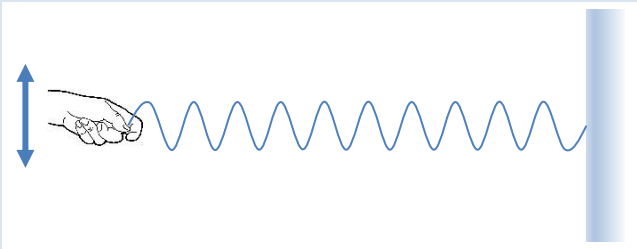
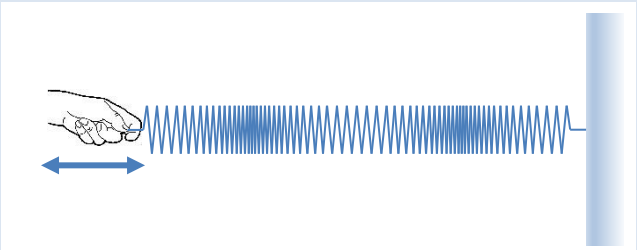


PRACTICE: DISTANCE BETWEEN CRESTS

A wave moves with a speed of 120 m/s. If the frequency of the wave is 300 Hz, what is the distance between wave crests?

CONCEPT: TYPES OF WAVES

- Remember! A wave is a moving oscillation
  - A wave then has an oscillation direction and a motion direction

TRANSVERSE WAVES	LONGITUDINAL WAVES
- Oscillation is _____ to motion	- Oscillation is _____ to motion
	
- Energy can be of MULTIPLE TYPES - Examples include: - Waves on a string - Water waves - Light	- Energy is POTENTIAL due to compression - Examples include: - Sound - Compression waves in elastic medium

- Periodic waves, regardless of whether it is transverse or longitudinal, have the same characteristics
  - As well, they both obey the speed relationship: $v =$ _____

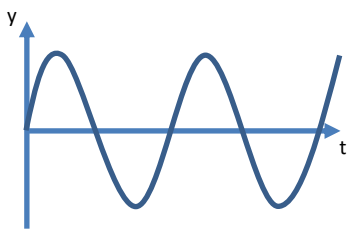
EXAMPLE: Can longitudinal waves propagate in a fluid? What about transverse waves?

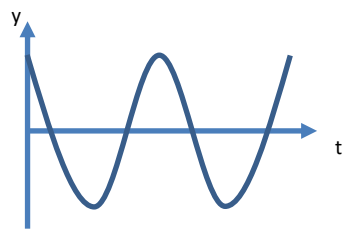
PRACITCE: WAVES IN A TSUNAMI

A satellite captures images of a tsunami, and properties of the tsunami can be found from these images, providing important information to people who need to evacuate coastal areas. If satellite images of a tsunami show the distance from one peak to another is 500 km, and the period is 1 hour, how much time do people have to evacuate if the tsunami is found to be 100 km off shore?

CONCEPT: THE MATHEMATICAL DESCRIPTION OF A WAVE

- Since waves are oscillatory, they are described by oscillating functions → Trig functions
  - The displacement that the wave begins at determines the type of trig function





_____ _____

- Waves don't just oscillate in time – they oscillate in space, too
  - A sine wave in time will also be a sine wave in position; the same applies to cosine waves

- A wave is more properly defined as a combination of oscillations in SPACE and TIME:

$y(x,t) =$ _____ or $y(x,t) =$ _____

- We have two important new values associated with waves:
  - WAVENUMBER: $\boldsymbol{k = 2\pi/\lambda}$
  - ANGULAR FREQUENCY: $\boldsymbol{\omega = 2\pi f}$

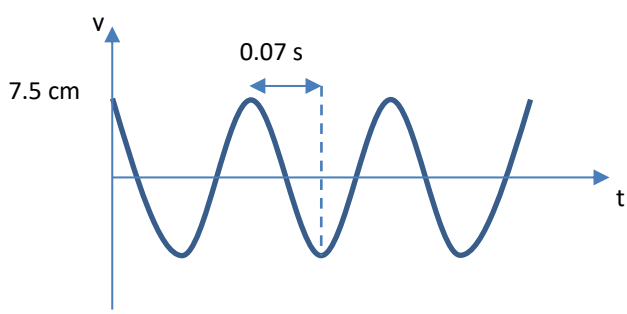
<u>EXAMPLE</u>: A wave is represented by $y = (0.05\ m)\cos\left[\frac{2\pi}{10\ cm}\left(x - \left(7\frac{m}{s}\right)t\right)\right]$. What is the amplitude, period, wavelength and speed of the wave?

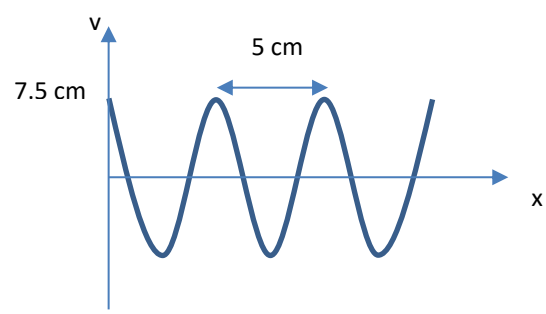
EXAMPLE: GRAPHS OF MATHEMATICAL REPRESENTATION OF WAVE

Draw the displacement vs. position and displacement vs. time graphs of a transverse wave given by the following representation: $y = (1.5\ cm)\sin\left[(2.09\ cm^{-1})x - \frac{2\pi}{0.01\ s}t\right]$

PRACTICE: MATHEMATICAL REPRESENTATION OF A WAVE GRAPH

Write the mathematical representation of the wave graphed in the following two figures.





CONCEPT: PHASE ANGLE

- A wave that begins with no displacement is a sine wave, a wave that begins with maximum displacement is a cosine
  - What if the wave begins in between?

- The best description of a wave is

$y(x,t) =$ _____ where ϕ is known as the PHASE ANGLE

- The phase angle is determined by the initial _____ of the wave.
  - A wave that begins with no displacement has $\phi = 0^o$ → a pure sine wave
  - A wave that begins with a maximum displacement has $\phi = \pi/2$ → a pure cosine wave
  - An arbitrary wave will have a phase angle between 0 and $\pi/2$

EXAMPLE: A wave with a period of 0.05 s and velocity of 25 m/s has an amplitude of 12 cm. At $t = 0$ and $x = 0\ cm$, the wave has a displacement of 8 cm. What is the mathematical representation of this wave?

PRACTICE: PHASE ANGLE

A transverse wave is represented by the following function: $y = (18\ cm)\sin\left[2\pi\left(\frac{x}{2\ cm} - \frac{t}{5\ s} + \frac{1}{4}\right)\right]$. What is the phase angle of this wave?

CONCEPT: VELOCITY OF A WAVE

- Remember! There are two types of waves: TRANSVERSE and LONGITUDINAL
  - Transverse waves have both a propagation velocity and a transverse velocity
  - Longitudinal waves only have a propagation velocity

- The PROPAGATION velocity depends upon two things: the _____ and the _____
  - This is a fundamental property of all waves!

- The equation of a wave can be rewritten as $y = Asin\left(\frac{2\pi}{\lambda}(x - vt)\right)$ using the definitions of k and ω
  - The propagation velocity is positive when we have $x - vt$, and negative when we have $x + vt$,

EXAMPLE 1: A wave is represented by the equation $y = (1\ cm)\sin\left((0.2\ cm^{-1})x - (1.7s^{-1})t\right)$. What is the propagation velocity? Is it positive or negative?

- The TRANSVERSE velocity is continuously changing → there must be a transverse _____

- The transverse VELOCITY and ACCELERATION of a transverse wave is

$v_T(x,t) =$ _____ with $a_T(x,t) =$ _____

- According to the above equation, the MAXIMUM transverse speed of a wave is $\boldsymbol{v_{T,max} = A\omega}$

  - Additionally, the MAXIMUM transverse acceleration is $\boldsymbol{a_{T,max} = A\omega^2}$

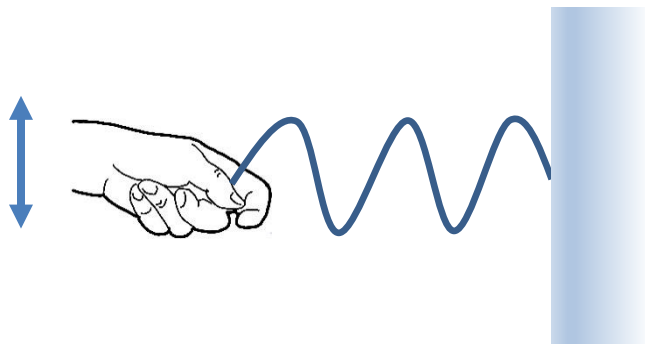
EXAMPLE 2: A longitudinal wave has a wavelength of 12 cm and a frequency of 100 Hz. What is the propagation speed of this wave? What is the maximum transverse velocity of this wave?

PRACTICE: MATHEMATICAL REPRESENTATION OF A TRANSVERSE WAVE

The function for some transverse wave is $y = (0.5\ m)\sin\left[(0.8\ m^{-1})x - 2\pi(50\ Hz)t + \frac{\pi}{3}\right]$. What is the transverse velocity at $t = 2s, x = 7\ cm$? What is the maximum transverse speed? The maximum transverse acceleration?

CONCEPT: WAVES ON A STRING

● A wave on a STRING is a common example of a _____ wave



● A wave on a string obeys all the same equations as other transverse waves – the only thing unique is the speed

● The PROPAGATION SPEED of a wave on a string is given by

$v =$ _____ where $\boldsymbol{T}$ is the TENSION and $\boldsymbol{\mu}$ is the MASS PER UNIT LENGTH

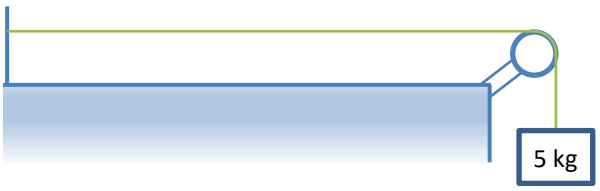
EXAMPLE: A 1.2 m string has a tension of 100 N. If it has a mass of 5 kg, what is the frequency of a wave with a 12 cm wavelength on this string?

EXAMPLE: UNKNOWN MASS OF A STRING

An easy way to find the mass of a string is to produce a wave on it. A 5 cm string of unknown mass produces a wave with a 12 cm wavelength that has a 70 Hz frequency when its tension is 10 N. Given this, what must the mass of the string be?

PRACTICE: FREQUENCY OF A WAVE ON A STRING

A 2 m long string is arranged as shown in the figure below. If the mass of the string is 0.5 kg, what would the frequency be of a wave with a 2 cm wavelength?



EXAMPLE: SPEED OF WAVE TRAVELING UP A STRING

A string is hung vertically from an anchor point. If you were to grasp the string at the bottom and shake it to produce a wave traveling up the string, what happens to the speed of the wave as it moves up the string?

CONCEPT: ENERGY CARRIED BY WAVES ON A STRING

- Waves on a string carry both KINETIC and POTENTIAL energy
  - The kinetic is due to the motion, and the potential is due to stretching of the string
  - This energy depends upon the _____, the _____, and the _____

- The KINETIC and POTENTIAL energies carried by 1 wavelength are the same: $\boxed{\frac{1}{4}\mu\omega^2 A^2 \lambda}$

- The TOTAL ENERGY per unit wavelength of a wave on a string is

  $E_\lambda =$ _____

EXAMPLE 1: A string 5 m in length carries a wave along its length. If the tension is 50 N and the mass per unit length is 0.005 kg/m, how much kinetic energy does the string carry for a wave with a frequency of 50 Hz and amplitude of 1 cm?

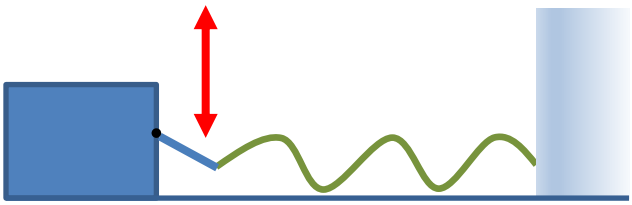
- The amount of time that passes for the wave to move one wavelength is the period, T
  - This is just the definition of the period

  → The power carried by a wave on a string is just $\boxed{P = \frac{1}{2}\mu\omega^2 A^2 v}$

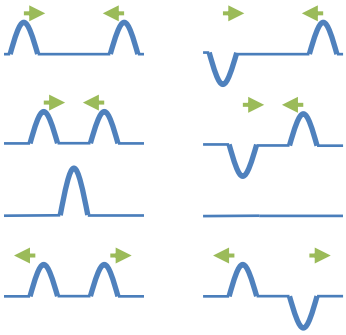
EXAMPLE 2: A 0.7 m string supports a wave of 0.05 m amplitude. If the mass of the string is 0.05 kg, and then tension on the string is 15 N, what must the frequency of the wave be to carry 100 W of power?

PRACTICE: MAXIMUM FREQUENCY OF A WAVE ON A STRING

Waves are produced on a string by a paddle that can move up and down, shaking the free end of a string to produce a 5 cm amplitude wave as shown in the figure below. The string has a mass per unit length of 0.5 kg/m and a tension of 100 N. If the maximum power the paddle can deliver is 50 W, what is the greatest frequency wave the string can support?

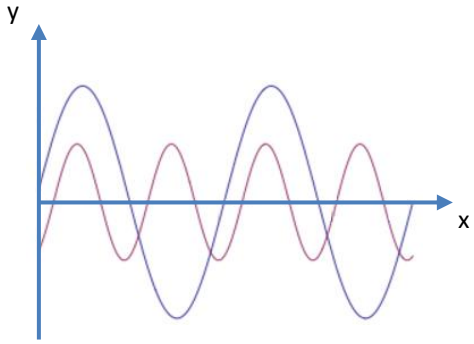


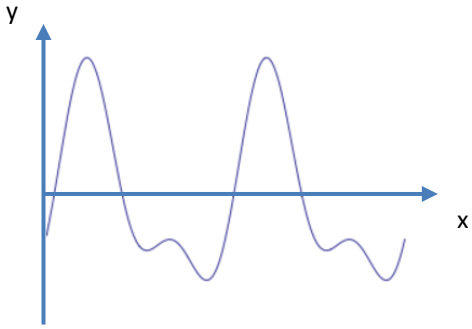
CONCEPT: WAVE INTERFERENCE



- Imagine two water waves approaching each other:
  - When they meet, they produce a NET wave
  - If peak and a peak meet, the net wave is _____ than either
  - If peak and a trough meet, the net wave is _____ than either

- When two waves occupy the same space at the same time, they INTERFERE – their displacements affect one another





- The resultant displacement of TWO INTERFERING WAVES is

$y(x,t) =$ _____

- Interference can be of two types:
  - CONSTRUCTIVE – when the resulting displacement is _____ than either wave's displacement
  - DESTRUCTIVE – when the resulting displacement is _____ than either wave's displacement

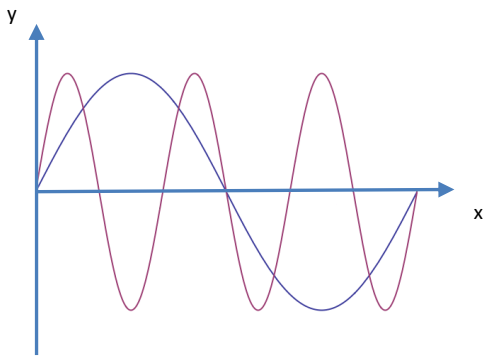
EXAMPLE: Two waves are emitted initially in phase, with $\phi = 0$. If one wave has an amplitude of 1 cm and an angular frequency of 10 s^{-1} and the second wave has an amplitude of 1.5 cm and an angular frequency of 15 s^{-1}, what is the displacement of the interfered wave at t = 5 s, at x = 0?

PRACTICE: REGIONS OF CONSTRUCTIVE AND DESTRUCTIVE INTERFERENCE

In the following figure, two interfering waves are drawn at some instance in time.

a) Indicate the regions on the graph where constructive interference occurs.

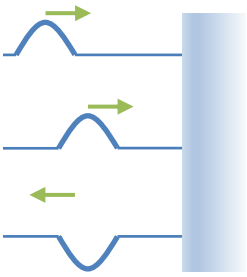
b) Indicate the regions on the graph where destructive interference occurs.



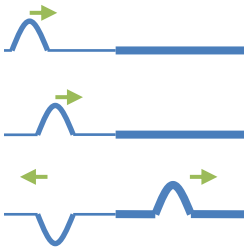
CONCEPT: WAVE REFLECTION

- When a wave encounters a boundary between two media, the wave can _____ or _____
  - Waves will actually do some of both

- WHENEVER a wave encounters a boundary, it exits the boundary at the same [WAVELENGTH / FREQUENCY]
  - This is true for both transmission and reflection
  - This is a FUNDAMENTAL feature of waves



- Imagine a wave heading towards a wall – this boundary does not allow transmission
  - When the wave encounters the wall, it REFLECTS off it
  - The reflected wave has the same frequency as the incident wave, and is inverted
  - The reflected wave then travels back towards the point of its origin



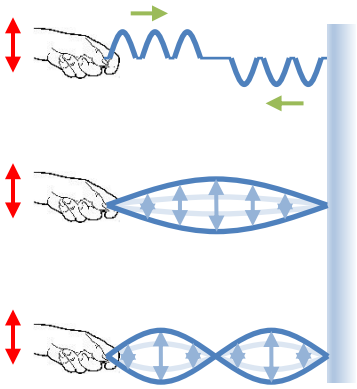
- Now imagine a wave on a light string heading towards a portion of the string that is heavier
  - This boundary (between the two different strings) allows transmission and reflection
  - The transmitted pulse has the same frequency and is upright
  - The reflected pulse has the same frequency and is inverted

- If there are multiple waves stretching along the entirety of the string, instead of just a single pulse, they INTERFERE

EXAMPLE: Whenever a string is fixed at a boundary, the wave along the string reflected off the boundary is always inverted. Why is this so? Would the wave be inverted if the string were free to move at the boundary?

CONCEPT: STANDING WAVES

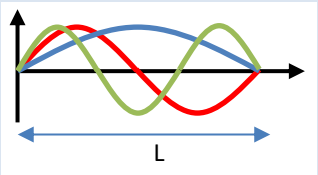
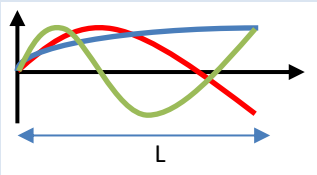
- Remember! Waves along a string fixed at a boundary will reflect backwards as inverted waves
  - These inverted waves will have the same _____



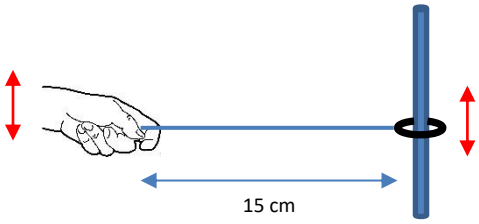
- Imagine holding the free end of a string fixed to a wall and vibrating it
  - Pulses will travel from the free end to the fixed end and reflect backwards
  - The inverted reflections will encounter the forward moving pulses
  - Forward pulses and reflections will interfere at the same frequency

- What will commonly be produced is an uncoordinated vibration – essentially nothing
  - However, at specific frequencies, STANDING WAVES are produced
  - A standing wave is a wave that APPEARS to be "standing" still

- Two types of a standing waves: NODE-NODE and NODE-ANTINODE standing waves
  -A node is a point of **NO-D**isplacement
  -An antinode is a point of maximum displacement – the opposite of a node

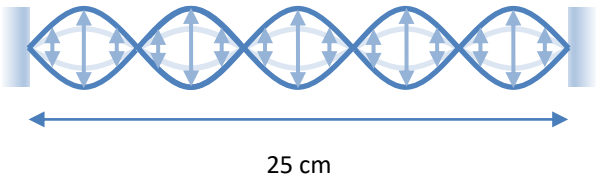
NODE-NODE STANDING WAVES	NODE-ANTINODE STANDING WAVES
- Both ends are nodes  - Allowed wavelengths: $\lambda_n = 2L/n$ - n is ANY INTEGER - Allowed frequencies: $f_n = nv/2L$	- One end is a node, the other an antinode  - Allowed wavelengths: $\lambda_n = 4L/n$ - n must be ODD! - Allowed frequencies: $f_n = nv/4L$

EXAMPLE: You want to produce standing waves on the string shown in the figure below by vibrating the end you're grasping. What is the third largest frequency producible on the string if it has a mass of 0.05 kg and a tension of 150 N? Assume there's no friction between the ring at the end of the string and the pole.



PRACTICE: STANDING WAVE ON A STRING

In the following figure, what is the harmonic number of the standing wave? The wavelength of the standing wave? If the frequency of the standing wave is 30 Hz, what is the speed of the waves producing the standing wave?



EXAMPLE: UNKNOWN HARMONIC FREQUENCY

A string fixed at both ends produces a harmonic frequency of 650 Hz, with the next highest harmonic frequency being 780 Hz. If the same string can produce a harmonic frequency of 390 Hz, what harmonic frequency is next highest?

EXAMPLE: STANDING WAVE ON A GUITAR

A guitar is played by plucking the string, which emits a sound at the frequency of its vibrations. To play different tunes, the string is held down by your finger at fret locations, each subsequent fret shortening the length of the string by about 2 cm. If a guitar string has a full length of 64 cm, a tension of 70 N, and a mass per unit length of 1×10^{-3} kg/m, what is the frequency emitted by the guitar if held at the 10th fret location?

PRACTICE: UNKNOWN MASS HANGING ON A ROPE

An unknown mass hangs on the end of a 2 m rope anchored to the ceiling when a strong wind causes the rope to vibrate and hum at its fundamental frequency of 100 Hz. If the rope has a mass of 0.15 kg, what is the unknown mass?

Fall 2023 - Roberts, Kevin Evaluation Packet

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