SANTA MONICA COMMUNITY COLLEGE DISTRICT
Faculty Evaluation Summary Form for Probationary Faculty
Year Three

NAME:	DEPARTMENT:
Kevin Roberts	Physical Sciences

OVERALL RATING

○ Satisfactory ○ Needs Improvement ◉ Unsatisfactory

Signature	Date
Dept. Peer: FOROUZAN FARIDIAN (Jun 16, 2025 23:33 PDT)	Jun 16, 2025
Dept. Peer: Emin Menachekanian (Jun 16, 2025 22:12 PDT)	Jun 16, 2025
Dept. Chair, faculty leader, or designee:	Jun 16, 2025
Evaluatee: Kevin F Roberts	Jun 17, 2025

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)
Please see comments on the next page of the packet.

Commendations & Recommendations

Kevin Roberts | Spring 2025

In Fall 2024, the committee gave Kevin several recommendations for how he should address some large issues associated with grading. After the close of the Fall 2024 semester, several student complaints came in about how late grades were posted, the fact that they walked into the final not knowing where they stood in the course, and concerns about how their exams and labs were graded since no assessments were returned. More details are described in the narrative written by Committee Chair, Jennifer Hsieh.

While Kevin made some progress towards the goals outlined in the Fall 2024 commendations and recommendations, the committee unanimously voted in support of giving Kevin an overall "unsatisfactory" on the Spring 2025 evaluation to underscore that Kevin has not made enough progress towards these goals.

As Kevin concludes his third year of the probationary process, he only has one semester remaining: Fall 2025. The committee feels that there are no additional recommendations to offer – the previous evaluations in the last three years are still very relevant. Kevin should review them and take to heart the recommendations made previously. As we go into the last semester of the evaluation period, the committee would like Kevin to demonstrate his best effort toward what he would look like as a tenured colleague.

The committee will kick off the Fall 2025 evaluation process on September 9 at 11:15 am via a zoom meeting. Prior to the meeting, the committee has requested that Kevin submit a written plan no later than Friday, September 5, addressing the following points:

- Elaborate on the issues that arose as a result of not grading assignments in a timely manner in Fall 2024, and grading those assignments using a vague rubric that was not centered in physics logic. Discuss how he will avoid being in this situation again.
- Describe a plan for scheduling the right amount of lab activities for the semester to complement the lecture and can be graded and returned promptly to support learning.
- Describe a plan for how he will prepare rubrics for grading exams prior to giving the exams and returning the exams in a timely manner (two weeks or less). Include a plan for dealing with absences.
- Describe how, if he is awarded tenure, he will manage his time to fulfill his other responsibilities as a tenured colleague, including service work, all while meeting his obligations to his students, like providing fair, consistent, timely feedback.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Spring 2026

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: Every time I observe Kevin students are very comfortable approaching him to ask questions.				
2. Communicates ideas clearly and effectively	●	○	○	○
Comments:				
3. Stimulates students' interest and desire to learn	●	○	○	○
Comments: Engages some students better than others. As noted in the observation notes document, about 1/3 of his Physics 8 class was disengaged, two were watching media on their devices.				
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: Still gets distracted at times, but the lecture notes definitely help.				

9. Maintains an appropriate pace during class session	●	○	○	○
Comments: Again, getting distracted with questions disrupts the pace.				
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: Assesses students progress regularly, but does not return work in a timely manner. Exam 2 was administered before spring break and has not been returned. Kevin has had the exams in his possession for 5+ weeks already.				
Additional comment: Please see additional notes attached.				

Date(s) of Visit: April 2, April 22

Length of visit: 3 hrs, total Course (if applicable): Physics 8 and 22

Conference Date: May 23, 2025

Evaluator's Signature: J M Hauer

Evaluatee's Signature: Kevin F Robiste

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

Spring 2025

Introduction

This iteration of observation notes will pick up where we left off with the final committee meeting in Fall 2024. At that time, the committee made the following recommendations for improvement:

1. Observe other instructors in the classroom, like committee members Forouzan Faridian or Emin Menachekanian, to learn how to give a productive, engaging prelab lecture.
2. Create clear lesson plans.
3. Create handouts to support students learning to analyze data in Excel.
4. Limit the number of outside commitments to focus on improving completion of instructional responsibilities, like grading, in a timely manner.
5. Prioritize grading exams.
6. Limit assignments to the basics, including labs, homework, and exams.

At the meeting, we discussed at length that it's important to write and grade exams that ensure an even distribution of grades, ranging from A to F. I shared past statistical data for grade distributions in physics with Kevin.

While Kevin was still very behind in grading assignments including exams, lab reports, group work, etc., he assured us that he would have everything graded by the time grades were due in January 2025.

January 2025

Kevin submitted grades to mProfessor on the due date, January 6th, 2025. The grade distributions were much closer to those you would expect for the physics classes he was teaching. He shared the percentages with me:

Physics 21	**Letter**	**# students**	**% students**
Final Grades	A	7	26.923
	B	8	30.769
	C	6	23.077
	D	3	11.538
	F	2	7.6923
	total	26	

Physics 23	**Letter**	**# students**	**% students**
Final Grades	A	9	29.03
	B	12	38.71
	C	6	19.35
	D	1	3.23
	F	3	9.68
	total	31	

The following day, after posting grades to mProfessor, students began emailing Kevin, me, OMBUDS, and eventually Academic Affairs and Admissions and Records because they were very surprised by their final grades. In total, I am aware of at least 8 Physics 21 students and 5 Physics 23 students that inquired about the results. All of these students were looking for a grade change.

According to emails that I received and communications from students when they knocked on my office door, students were under the impression that (1) they were doing very well in the course prior to the final exam because Canvas showed their grade at very inflated with scores like 120%, due to all of the large point assignments left ungraded; and (2) they would have the opportunity to submit test corrections to improve their exam scores. Kevin reported to me that test corrections were an option that he offers should the exam average be lower than expected. He also reported that none of his exam averages were very low. For one or two, he opted to curve the scores instead.

March 11, 2025

Kevin met with his evaluation committee to discuss the upcoming evaluations and to discuss the issues surrounding the 13 students referenced above that expressed concerns with their final grades. After significant discussion, the committee learned that Kevin had run out of time to complete his grading and resorted to a very simplified grading rubric. As an example, after the meeting, Kevin shared his rubric for Physics 23, Exam 2, Fall 2024. In the rubric, he provided the following:

Question 1:

Part a

+3.0
Use $pV = nRT$ to calculate the number of moles

+3.0
Use $N = nN_A$ to calculate the number of molecules

-1.0
calc error

-0.5
missing units

part b

+5.0
Find the number of molecules in 1 cm^3 at 1 atm

+2.5
some attempt

-0.5
missing units

Questions 2 – 5:

+20 points	correct
+17 points	very good
+15 points	good
+12 points	fair
+8 points	some attempt
+4 points	set up equations

The point distribution arrangement for questions 2 – 5 is unusual for any physics class. To understand how the points were awarded using this rubric, the committee requested to see some of the graded exams. The sample exams provided were not annotated by Kevin, he just reviewed them and entered a score directly into an Excel spreadsheet. The approach used to grade questions 2 – 5 was inadequate at best. In an attempt to mentor Kevin, one of the committee members, noted as FF in the table below, graded the sample exams as if they were their own. FF created a standard rubric and annotated the exams. We all had a chance to see how using a detailed rubric centered around the actual work needed to solve the problem impacted the students' scores.

	Kevin's Scores	FF Scores	FF Curved Scores	difference (K-FF)
Student A	43.0%	21.0%	26.4%	16.6%
Student B	66.0%	39.0%	49.0%	17.0%
Student C	28.0%	15.0%	19.0%	9.0%
Student D	92.0%	73.0%	92.0%	0.0%
Student E	80.0%	23.5%	29.6%	50.4%

Five student exams from Physics 23 were graded by both Kevin and FF. Notably, FF's scores were lower than Kevin's scores. To make a more even comparison, FF curved their scores by normalizing the scores using student D's 92%. Using the simple rubric that Kevin created resulted in students benefitting from significantly higher scores, where one student earned a score that was 50.4% higher in Kevin's grading scheme than FF's.

The committee has stressed to Kevin that this sort of grading is inadequate. I maintain that it leaves the students with a false sense of understanding. How can it be that one tenured full-time instructor would give student "E" a failing score of 23.5% uncurved, and our probationary full-time instructor would award the same student a passing score of 80%. This level of inconsistency will create problems for our students as they transfer and move on to upper division course work. It will also hurt the health and viability of our physics program. If students do poorly upon transfer, they will no longer recommend to their peers to enroll at SMC for their physics coursework.

Spring Grading Status Check

Given the challenges with grading in the Fall 2024 semester, I made a point of periodically checking on Kevin's progress with grading. Kevin is teaching Physics 8 and Physics 22 this semester. Below is a current list of Exams, when they were administered, and when grades were posted:

Physics 8

Exam 1

- Administered Thursday, March 13
- Scores posted by March 18

Exam 2

- Administered Wednesday, April 9
- Scores have not been posted as of Friday, May 16, 8:10 pm
- I emailed Kevin on April 21, for a status update. Kevin said, "I unfortunately didn't get very far in the grading of my exams over the break, but I plan to grade them over today and tomorrow." Today and tomorrow references April 21 and April 22.
- I emailed again on Monday, May 12, to inquire about exam 2 grades and, as of May 16, 8:10 pm, Kevin has not responded.

Physics 22

Exam 1

- Administered Thursday, March 13
- Scores posted by March 18

Exam 2

- Administered Wednesday, April 10
- Scores have not been posted as of Friday, May 16, 8:10 pm

- The comments noted for Physics 8 apply to Physics 22. On April 21, Kevin indicated the exams would be graded soon. I inquired again on Monday, May 12, and have not received a reply.

Today, May 16th, is two days before the last day for students to withdraw from a course. Students rely on accurate, up-to-date grades to decide on whether to remain in the course or withdraw. In addition to the missing exam scores, Kevin has not posted any lab scores for some time. For Physics 8, Kevin has only posted scores for labs 1 – 4. Students collected data for lab 4 on March 26. Since March 26th, students have completed labs 5 – 9, where lab 9 occurred on May 14th.For Physics 22, Kevin has only posted scores for labs 1 – 3. Students collected data for lab 3 on March 6th. Since March 6th, students have completed labs 4 – 9, where lab 9 occurred on May 6.

Classroom visit, Physics 8, April 2, 11:50 am – 1:30 pm

The Physics 8 class started at 11:30 am, I arrived 20 minutes into class. At the time, it appeared that most of the enrolled students were in attendance. This class is scheduled in the large lecture room, Sci 140. I counted 9 students sitting in the back, mostly looking at other things on their laptops or texting. Of this group of students in the back, one started napping around 1 pm. Around the same time, another student was watching TikTok reels, and a third student was watching a movie with her AirPods in. When teaching in a large classroom, it's ok to require students to sit in the front half of the room. It's also a really good idea to get up from the instructor's bench and walk around to engage with all of the students.

Kevin had a solid group sitting at about 1/3 of the way from the front of the room. They asked a lot of engaging questions and Kevin really fed off of their energy.

Kevin was covering newton's laws. His slides supported his lecture adequately and it was nice to see him using an outline that helped keep him on topic. The diagrams supported his narrative. There was once or twice when it felt like Kevin was adlibbing an answer to a question, but the answer was involved enough that I wasn't sure if it was part of the planned lecture or not. One occasion centered around the discussion of why the earth does not collapse on itself. If I am left wondering if this discussion is part of the curriculum, it begs the question, what are the students thinking. As I've noted before, Kevin needs to work hard to stay on topic. It was notably better, but there is still work to do here.

After the break, Kevin did a "quick check" #2. I think these quick checks are a good addition to the class, however, the mode of collecting responses was not effective. Nearly everyone sat quietly and then Bella blurted out the answer "B". Then Kevin said it's actually "E". There are many ways to take a quick poll that would encourage students to attempt solving the problem. I noted that the girls in the back of the room didn't even look up from their devices to look at the question, let alone respond.

Classroom visit, Physics 22, April 22, 3:40 pm – 5:00 pm

I visited Kevin's Physics 22 class on the day when they were scheduled to do Experiment 7, the RC Circuit lab. I arrived too late to observe the prelab, but I got a chance to watch the students work. For once, it appeared that the students were given enough time to set up the lab and collect the data. No one appeared to be rushing, and the students seemed like they were able to finish collecting the data by 5 pm.

As an "outside" observer that does not know how to use the oscilloscopes and function generators, it was interesting to watch the students. Some appeared to have a decent idea of how to set up the equipment and record the data. Other groups struggled to get things set up correctly and it took Kevin considerable time to evaluate their setups and correct the incorrect settings. As I was unable to witness the prelab, it's difficult for me to say why some groups were having more difficulties than others.

It seemed like the students were better prepared with their Excel files this time. I'd like to know more about the changes Kevin implemented in this regard.

Miscellaneous notes

As noted in the opening section of these observations, the committee recommended that Kevin visit another instructor's class to observe and learn how other instructors give prelab lectures. To date, May 16, Kevin has not visited Emin or Forouzan's class, nor has he made an attempt to set up a time to visit.

Given the significant improvements that Kevin has been asked to make, the committee recommended that he submit a plan for professional development by May 16th, like the first- and second-year processes. At the time of writing this, May 16th, 9 pm, Kevin has not submitted a plan for professional development.

Reviewing Kevin's Canvas shells, it appears that he has taken the advice of the committee and reduced the student workload down to the basics: lab reports, homework, and exams.

Kevin has also limited his outside commitments to just serving on the Curriculum Committee. He has not subbed any classes this semester and to the best of my knowledge, he has not worked on any other projects.

Summary

I appreciate that Kevin has taken some steps to improve the outcomes of his teaching. As noted, he has edited his coursework to focus on the traditional materials of lab reports, homework, and exams. He is focusing on this teaching rather than other service components. However, I am deeply concerned about his progress with grading. Given all the streamlining that Kevin has undertaken to create more time to grade assignments, he is still very behind schedule with grading. I want to stress that grading exams using a rubric like the one used for his Physics 23 course in Fall 2024 listed earlier is unacceptable, the students deserve better. I do hope that Kevin will be able to turn the grading around for the end of the semester.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Spring 2025

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:				
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: I enjoyed the think-pair-share activities being done in the lecture that was observed.				
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: For the single observation adminstered, the class did start somewhat on time. However, the ending time was not observed.				
8. Uses class time efficiently	○	●	○	○
Comments: Details are provided within the narrative, both touching on aspects of digression, as well as on handwriting efficiency.				

9. Maintains an appropriate pace during class session	●	○	○	○
Comments: The pace is not fast, but I think it could be less slow, particularly as it pertains to the handwriting discussion described in the narrative.				
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: Please see the narrative regarding the long turn-around time for high-stakes items, like exams.				

Additional comment:

Please see the attached narrative for further details regarding the rationale behind the way this form was filled out in accordance with the class observation, as well as for a review of other aspects regarding the courses being taught.

Date(s) of Visit: 04/23/2025

Length of visit: 65 minutes Course (if applicable): Physics 8

Conference Date: 05/22/2025

Evaluator's Signature: [redacted] Emin Menachekanian (Jun 16, 2025 22:12 PDT)

Evaluatee's Signature: Kevin T 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

May 16, 2025

A single observation took place for Prof. Roberts for his Physics 8 class in Spring 2025 on Wednesday, 04/23/2025 in SCI 106 from about 8:00 am - 9:05 am. The class was originally going to involve a lab on momentum, but in an announcement the day before, the lab was deferred to the following week. Instead, the day of the observation would be devoted to a lecture on energy. The class started a few minutes late. Most of it was spent trying to set up his tablet and laptop. There were about nine students once class started at 8:06 am, and by 8:20 am, there were 14 students. This number wouldn't change for the rest of the roughly hour-long observation. I'm not aware as to the actual size of the class, but I would wager to guess that the class likely was above 18 students at the beginning of the semester. So, either some students had dropped by this point in time, or there are some that did not show up to class. I'm not sure if the announcement of the lab's postponement had anything to do with it, so that some students opted not to show up since there was not going to be a lab on that day. In any case, Prof. Roberts passed out a sign-in sheet for students who were present to make note of their attendance. I think that's certainly a good thing to hold students accountable in terms of participation in the course itself.

The atmosphere in the class was pretty good. The students seemed quite respectful of Prof. Roberts, and most were paying fairly close attention to what he was presenting. His presentation made use of an iPad on which he was presenting pictures and writing down equations and statements. In other words, that's his replacement for directly using the whiteboards in the classroom. He also had a laptop, and from what I was able to tell, he was likely using it as a way of displaying his own notes to himself to keep him on task with the lecture. Prof. Roberts was clearly quite fluent in his use of this equipment, and I think the students appreciated the attention to detail: using good pictures; using good handwriting; zooming in and out of the canvas when needed; etc. One area on which Prof. Roberts can improve concerned when he wrote down phrases or sentences. I think they took a very long time to write down. I think part of this might be owed to it being relatively hard to handwrite well on the iPad if one does it at a similar pace to when writing things on paper. I can speak to this myself, as my handwriting is substantially poorer on my iPad than on a piece of paper when I try to handwrite at the same speed. As such, I tend to write much slower on the iPad to compensate.

There are some avenues for improvement on the handwriting speed. One would be to make use of a screen protector with purposefully more of a grained surface (i.e., with a little more resistance when moving the stylus across it). This latter point was mentioned in a prior observation narrative. Another suggestion would be to do away with handwriting sentences altogether, and use a keyboard to jot down such things. One could still use the stylus for handwriting equations, as that's generally harder to do efficiently while typesetting with a keyboard. It would, of course, require a bit more of a delicate dance between using the various devices, but it might end up making the lecture flow much better. I know that Prof. Roberts types relatively quickly, so that it could not only be more efficient, but that extra time gained from having to handwrite sentences can be used to instead reiterate the points, or even to describe the statements in a different light (or even with added diagrams). Again, I do think discussing content at a slower pace is a good idea, as it gives students some time to let the content sink in, but I still think that writing the statements down more efficiently can still lead to that, as the notions can be reinforced in the spare time achieved with this added efficiency.

As for the content being presented, the lecture started with a bunch of different energy transfer examples. He used prepared pictures on his iPad's canvas, with which he narrated and annotated the pictures with relevant equations and written information. The pictures were definitely nice, as they did capture the essence of the transfer mechanism. In one case, he was showing off a shot-putter on the verge of throwing a heavy ball, which was an example of work resulting in kinetic energy. In another case, he showed a person who had already pulled back the rubber band attached to a slingshot, which was an illustration of work resulting in potential energy. Yet another example involved a diver jumping off a cliff towards a body of water, which was trying to showcase the transfer of potential energy into kinetic energy. I think with this latter example, it might have been useful to make a mention of how this can still be thought in terms of work transferring into kinetic energy. As will be discussed later, I know that this may be difficult to implement given the closeness with which Prof. Roberts seemed to be following the book, but I think it could have been taken as an opportunity to at least foreshadow things to be covered later. Yes, unlike the shot-putter example in which the shot-putter is doing work on the ball to make it gain kinetic energy, in the case of the diver, it's really the Earth's gravitational force that is doing the work; nevertheless, it might have been worthwhile to connect that more directly, so that students don't think of the two examples (work to kinetic energy versus potential to kinetic energy) as necessarily separate phenomena. They are essentially one and the same, but thought of in different perspectives.

Eventually, Prof. Roberts transitioned into a discussion about thermal energy. For instance, he described how kinetic energy can be dumped into thermal energy with an example of a meteor burning up in Earth's atmosphere. I think it is a smart strategy to introduce students in Physics 8 to thermal energy sooner than later. Indeed, since the

class is meant to cover thermodynamics in the latter part of the course, then having students see some examples of simple mechanical systems that naturally generate a change in temperature is a good way to plant the seed for when they uncover it in more detail in the future. Nevertheless, I do think there are some instances in which the content veered a bit too off topic. For instance, Prof. Roberts tried to connect the thermalization of the meteor to entropy. Sure, if students have seen entropy from past classes, then maybe they can make a connection; however, even then, making a mention of it in such a vague way might provide too muddled a perspective on the task at hand. Again, I get that he may be trying to plant a seed, but the connection was mentioned for the sake of mentioning it, instead of maybe taking a few additional minutes to plant a better seed on how it connects. Trying to spend a few minutes on that may not be enough, so I would have altogether not mentioned it for the sake of minimizing confusion.

Another digression that was a bit out-of-place concerned symmetry breaking. It is true that symmetry breaking does lead to a shift in energy, but I really don't think this is the best place to introduce that. I'd even steer clear of mentioning it in a physics class that is geared towards scientists and engineers, as that's normally something you'd be more invested in discussing at a relatively high-level upper-division class, or perhaps even a graduate course. Yes, there are some systems that exhibit this that could be described (e.g., ferromagnetic materials that are subjected to a variable temperature), but it seems like a long-shot to even make sense of it within an introductory class, let alone an introductory class for students who likely won't be going into physical sciences or engineering. I definitely appreciate Prof. Roberts' enthusiasm regarding physics of all types, but I could tell that students were a bit confused by what he was trying to say about symmetry breaking leading to energy shifts. Fortunately, he only mentioned it in passing, but I think it should have perhaps been left out altogether.

A final note about digression—which may have been a bit detrimental to the students' understanding of energy—involved a few statements about total energy. Prof. Roberts mentioned that total energy will be conserved *in this class*, so that it may change form or possession, but never change as a whole. Honestly though, there's no robust, practical example of total energy ever not being conserved, so that emphasizing **this class** was a bit off-putting. Sure, there may be instances in which it looks like total energy is not conserved, but that's just a consequence of not understanding into what degrees of freedom it is going. There are obscure examples of this, such as in discussions about black holes and the famous debates that took place between Stephen Hawking and Leonard Susskind when Hawking made a more general proposal about information loss due to a black hole. Even then, the example is very obscure and seemingly has multiple ways it can be circumvented, none of which is necessarily fully grounded within the experimental evidence.

Even in the advent of Einstein's mass-energy propositions from his theories of relativity, any loss of energy (at least in its classical namesake) has a means of being tracked, so that the total energy (or mass-energy, if you like) is still conserved. In any case, I think had students been more knowledgeable about the topic from the get-go, this may have spelled a lot of trouble for Prof. Roberts. Indeed, if they called him out on it with a discussion geared towards so-called "perpetual-motion" machines, then it would be really hard to get back on track. Indeed, Prof. Roberts mentioned further that this class (Physics 8) will not treat cases in which energy is created or destroyed. Again, mentioning such a thing is a bit of a slippery slope, as that is realistically not something that can be done in the first place. Indeed, if you're thinking that energy is being created or destroyed, then the explanation is that you're not understanding from where, or into what, energy transfers are occurring. In any case, it might be worthwhile to try to keep on-topic as much as possible. If some interesting thing is mentioned in passing, then it should be done in a way that doesn't promote confusion, but rather maybe entices students to think more about the notion on their own time.

Moving on with the content presented, Prof. Roberts drew the diagram in Figure 1, which is my own drawing of what he had shown on the projector via his iPad. I thought it was nice to try to put an all-encompassing diagram for students to use in their investigation of energy.

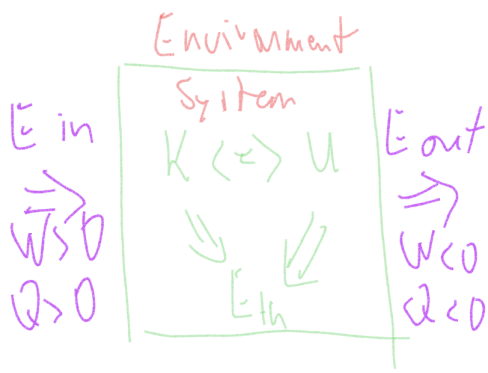

Figure 1: *My drawing of an energy flow diagram that was drawn by Prof. Roberts during my observation on 04/23/2025.*

Again, maybe some of the aspects of thermodynamics included in the figure (such as heat transfer in the form of the symbol, Q) could be kept to the future. In other words, one could just recall the diagram and modify it to include thermodynamic considerations when the time is right. To make the preliminary diagram lack information about thermodynamics may have been more useful for the present, mechanical considerations.

There was one student in particular who was asking questions of Prof. Roberts as the lecture was being presented. He asked some really good questions, and Prof. Roberts did his best to answer them. When discussing the meteor example, this student asked, "Can you say that the air molecules are doing work on the meteor?" Prof. Roberts responded well enough about this, although it was still unclear how a force dotted into a displacement really comes about here. In any case, after the energy flow diagram of Figure 1 was presented, the same student asked, "Why is change in kinetic energy the only thing that results when net work is being done? Can there be other forms, such as if net work is done to change the potential energy instead?" This was a great question, but Prof. Roberts did not answer it well. He brought in a lot of thermal aspects to explain the question, which was not really helpful in hindsight. In the end, I think a good explanation would have been to at least mention the Work-Kinetic-Energy theorem, as well as to briefly describe conservative and non-conservative forces. Now, based on what was seen in the latter part of the observation—in which he started developing the notion of work and kinetic energy for a single particle—I suspect that he is following the book's presentation of the topic pretty closely. Indeed, the author of the book, Knight, introduces various concepts of energy first before then diving into work (which is a similar approach to Feynman and his lectures).

In any case, this question could have been taken as an opportunity to plant the seed of what's to come. I'm not sure to what extent Prof. Roberts had already described conservatism of forces, but I think it's really necessary to describe that to be able to answer this question. In the end, I think a worthwhile answer would have at least mentioned that work can alternatively be computed by using potential energies. In some ways, one need not necessarily even bring up a formal discussion of conservatism to address this issue. Really, one could, for example, just calculate the work done by a gravitational force, and then compare it to the answer one would get if you compute the negative of the change in the gravitational potential energy instead. This latter approach would rely on whether or not students have seen some preliminary ideas of work already. If not, then it could at least be taken into consideration for when they will see it more formally in the future. Ultimately, the question can be fully answered by looking more closely at the Work-Kinetic-Energy theorem, showcasing that the net work is the change in the kinetic energy, and that a combination of the individual work calculations to compute the net work (either none, some, or all) can be written in terms of the negative of the changes of the associated potential energies.

Most of the rest of the class was then spent on developing the concept of work and kinetic energy for a single particle. One of the hugely successful things that was done by Prof. Roberts in this part of the content was to implement some think-pair-share activities. During my observation, there were two such activities done. The questions were not overly complicated mathematically, but they were really good at providing a quick check for understanding. Moreover, the questions were really great at improving participation. When lecturing, practically only one student (as mentioned before) was asking all of the questions; however, through the think-pair-share activities, more students began asking questions and were genuinely curious about the way to do the problem, whether or not they ended up getting the correct answer. Some students felt comfortable discussing things with their neighbors, while others preferred to work individually. All in all, whether they paired up or not, I could easily sense that all students were invested in the activity. That was a great addition that I had not seen Prof. Roberts implement in past observations, so I wanted to commend him for consciously deciding to include this into his teaching plan.

I also enjoyed how these activities flowed smoothly from his lecture with the help of his iPad. Because these activities were already slated to happen, the back-and-forth transition between lecture and activity was quite seamless. For the most part, Prof. Roberts is also very passionate and giddy about the content. There were some moments during the lecture where he was presenting the material while propping his head onto his hand (with his elbow being supported by the workbench where he was sitting). I don't know if he was tired, but it was a way that I have generally not seen him, whether inside or even outside the classroom. Even during the class, there were moments where his energy suddenly sprang up, but I'm not sure if he could potentially benefit from having a setup where he is able to stand while lecturing as well. In this way, maybe it would be easier for him to take a stroll away from the iPad while making some statements. He could even diversify and make use of the whiteboard to illustrate something quick that he would like to be more permanently in students' views. In the end, I can feel that his style of presenting material using his iPad has become more comfortable for him. I think the students appreciate the style as well, but I think there are certainly some ways that the presentation can be improved, as described before.

From a broader point of view, it has been reassuring to see Prof. Roberts take some of the committee's advice since Fall 2024. For one thing, I'm glad he trimmed down the number of assignments for which students are responsible. At this point, it looks like students turn in pre-labs and lab worksheets, and they submit online homework.

Also, the syllabus has a clearer organization, and I think the expectations are outlined much better than before. There are some areas that can be made more transparent. For example, it lists that lab reports are 20% of the grade, but it looks like the pre-labs are worth one fifth of the lab reports themselves. Since the category with 20% is called

"Lab Reports," it seems as though the pre-labs are not included. Maybe it might be wise to either make two categories, Lab Reports and Pre-Labs, and say that the pre-labs are worth 3.33% of the grade, while the reports are worth 16.67%; or maybe that the category is renamed so that it more broadly includes both items.

With respect to the grading scale listed on the syllabus, it makes it seem that it's on a straight-scale. I'm not sure if this is ever adjusted, as I know in the past that he has "curved" the grades to some degree. Maybe it might be worthwhile to put a clause on curving, mainly to be clear if it is ever done. Again, perhaps curving is not being done anymore, but it may be prudent to clarify, especially since he has done it in the past.

Moreover, I know that Prof. Roberts was keen on making use of "exam wrappers," in which students submit a reflective assignment on the exam itself. It looks like there is an invisible column for this within the gradebook on Canvas, but there was no mention of it in the syllabus itself. It was unclear to me through the syllabus whether or not he is implementing this, as I recall him expressing his intention to do that within this semester.

On a different note, as compared to Fall 2024, Spring 2025 has been a little better in terms of getting tests graded. For instance, Exam 1 was graded quite promptly for both classes. However, for Exam 2, that has not been the case. As of the evening of 05/14/25, nothing had been graded for either one of his classes, and it has been well over a month since the tests were administered. When checked at noon on Friday, 05/16/25, his Physics 22 Exam 2 was still untouched, but his Physics 8 Exam 2 was about one-third of the way graded. This is still an area that requires major improvement, and I'm not entirely sure why not even a little progress had been made in grading either of these particular exams after such a long duration. As suggested in past meetings, I think the way a more appropriate exam turn-around time can be achieved is to work on grading them in a more consistent fashion. Once a clear rubric is set up, Prof. Roberts can plan on spending, say, one hour each day to grade, say, one or two problems. In this way, it would be quite trivial to get the exams back to the students no later than 1.5 - 2 weeks after administering them. In this way, it would then make sense to have the aforementioned exam wrappers, because if the exams are not turned back to the students in a timely manner, then they won't have the ability to reflect on it in the first place.

As a final note in this narrative, it is worth mentioning that Prof. Roberts has made great strides in his role as the department's curriculum representative. He has seemingly learned a lot about how the Curriculum Committee works, and has already helped many colleagues in his role. Moreover, he has put in a good amount of effort to write up the Physics Associate Degree for Transfer, and the physics program has since approved the document to be pushed into a departmental vote during the next department meeting. If approved there, it will officially enter the curriculum pipeline for further approval by the Curriculum Committee in early Fall 2025.

In addition, I also appreciate Kevin's enthusiasm during our program and department meetings. He is always willing to participate in the various discussions and activities that we have, and he tends to ask quite poignant questions during these meetings as well. I also enjoy catching up with him in the hallway or in the physics stockroom.

FACULTY OBSERVATION FORM

Evaluation of: Kevin Roberts Semester: Spring 2025

Department: Physical Sciences

Evaluator: Forouzan Faridian Position: Associate 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: At the beginning of my observation the students were engaged in a lab activity. They felt free to ask for help.				
2. Communicates ideas clearly and effectively	●	○	○	○
Comments: Lecture slides were organized and clear.				
3. Stimulates students' interest and desire to learn	●	○	○	○
Comments: Professor Roberts used good examples to tie the lecture on magnetic torque to motors and discussed magnetic material.				
4. Promotes active involvement of students in learning activities	●	○	○	○
Comments: The observed class was a combination of lab and lecture.				
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: I started the observation at 3:30 PM. The official class start time is 2:30pm, which I was not able to observe. The class ended at 4:52 pm.				
8. Uses class time efficiently	○	●	○	○
Comments: During the lab portion, the lab sheet had minimal instructions. A guideline for Excel or data entry added to the sheet would prevent the issues that many were having, which resulted in each group asking for professor's Roberts help for clarification of what to do.				

9. Maintains an appropriate pace during class session	◉	○	○	○
Comments: The class was a combination of lab and lecture, and the pace was appropriate.				
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: Professor Roberts gave specific examples of where soft magnetic materials can be used vs. where hard magnetic materila are used,				
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: Professor Roberts was able to answer all the questions the students posed.				
15. Assesses students' progress regularly	○	◉	○	○
Comments: There seems to be a large gap between the time exams and labs are given and when they are graded.				

Additional comment:
As of week 14, on Canvas only the homework and the first few labs and first exam grades have been uploaded. Students have a right to know how they are progressing in the course, and this problem has not been addressed.

Date(s) of Visit: 4/29/2025

Length of visit: 90 min Course (if applicable): Physics 22

Conference Date: 5/29/2025

Evaluator's Signature: [signature]

Evaluatee's Signature: Kevin 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.

Probationary Faculty Classroom Observation details for Spring 2025: Professor Kevin Roberts

I observed Professor Roberts' Physics 22 classroom on April 29, 2025. As our schedules overlap, I was able to observe the class an hour after its start. The class was engaged in a lab activity for another half hour, making the total lab time 90 minutes. Professor Roberts engaged in lectures for the next hour.

1. Classroom observations:

   Lab observations:
   The lab groups were well organized and well positioned in lab stations around the room. They were engaged and the lab environment was safe and conducive to learning. It was nice to see that Professor Roberts has changed the number of students per lab in order for them to be able to use the lab benches and not the instructor bench. The lab groups had a printout of the lab to be performed; however, there was no instruction on how to fit a curve using Excel. This resulted in each group asking Professor Roberts for help and he had to go from group to group to show them how to fit their data.

   Lecture observations:
   The lecture on magnetic torque went well with Professor Roberts using slides that he would complete by writing on his iPad. The lecture was organized, and he did give a couple of short extra explanations on applications of "soft" magnets and "hard" magnetic material. Two examples were embedded in the lecture (Magnetic torque on a circular coil). Professor Roberts proceeded to solve them. However, he did not ask students to work on it before he solved it. The two examples given were actually solved examples from the textbook. I did not observe any short conceptual think-pair-share questions or opportunities for students to solve sample problems on their own.

   Possible growth areas and suggestions:

   Lab: It was very nice to see that the organization of the lab groups was well done and working. Overall, the lab was going well. I suggest having also a separate resource sheet available for Excel use, so students have a reference. Alternatively, the professor can stop the class and take the same few minutes spent explaining to individual groups to the entire class instead.

   Lecture: The lecture was well organized. Using a few conceptual questions as think-pair-share to gauge the understanding of students and clarify concepts can be very useful. Also, it would be nice to use examples from other sources (other textbooks, old AP questions, questions from the test bank) to solve as opposed to using the textbook's that the students already have access to. Professor Roberts spent one hour lecturing on two and a half sub-sections of chapter 27, writing on the slides. While the lecturing was clear, I feel some of the writing could have been already placed on the slides and more time

could have been spent on a couple of conceptual think-pair-shares and a couple of examples not already present in the book for students to work on.

2. Canvas shell observations and grading:

   For Physics 22, the blank lecture slides are uploaded and so are the filled lecture notes, so students have access to the information. The lab sheets are also uploaded. I was not sure why there were some Phet labs linked when the lab sheets seemed to be referring to in-person labs. Looking for students' work on those labs, I realized that none of the labs since lab 4 have been graded.
   Exam 2 has been graded, and Professor Roberts had promised to finish Exam 3 grading by today, Friday, May 30th. As of 6 PM, there were no Exam 3 grades entered in either Physics 8 or Physics 22 Canvas shells.

   On the syllabus, it is stated that 50% of the grade is based on the exams, and 20% on the labs. At the conclusion of week 14 out of 16 in the term, only 2/3 of the exams and 4/12 labs have been graded.

   It seems that there is a major delay between when exams are given and their grading. Exam 2's grade was recently uploaded, but Exam 3 has not, even though it was given three weeks ago. This was pointed out during last semester's evaluation of Professor Roberts. It seems that Professor Roberts has created a Rubric for his exam; the key is to spend time grading the exam right after. As this was also an issue last semester, I was hoping to see that Professor Roberts has already come up with a plan to resolve this very essential problem of grading the students assignments on time. Providing timely grades is one of the major cornerstones of an instructor's responsibility.

In general, there has been an improvement since last term's observations in terms of the organization of the labs and lectures. There is still room for growth in terms of the quality of lectures and of the laboratory handouts and directions, by streamlining and focusing on what is important for the students to learn. What does need to be addressed urgently is the grading. Professor Roberts has decreased the number of assignments, but there are still items such as pre-labs that seem to be very extensive and time consuming both for students and for Professor Roberts to grade. Timely grading of assignments, especially exams, is essential.

Professor Roberts continues to contribute to the department by serving as the curriculum committee representative. He helped with choosing equipment to order for the new Physics lab and helped with opening boxes and ordering the equipment of faculty flex day. He also continued to work on the certificates of achievement in Physics for our students. He is also planning to work on the organization of Physics 22 labs. It is always a pleasure to talk to Professor Roberts.

Forouzan Faridian

PROFESSIONALISM FORM

Evaluation of: Kevin Roberts Semester: Sp'2025

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: Committee provided Kevin with ample feedback in the Fall semester and again at the start of Spring semester. He has only acted on a small fraction of the recommendations. The most important recommendations, like returning exams quickly, has not improved.				
3. Participates at the appropriate level in creation, assessment, and / or discussion of SLOs	○	●	○	○
Comments: Did not submit SLOs in Fall 2024.				
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:				
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:				
10. Participates in departmental and campus wide activities	●	○	○	○
Comments: Serves on Curriculum Committee, has provided feedback for the Chem Tech program as it goes through Curriculum.				
11. Maintains currency in professional knowledge through professional literature, professional memberships, workshops, conferences, or other activities	●	○	○	○
Comments:				
Additional comment: Please see my additional notes in the attachment.				

Conference Date: May 23, 2025

Evaluator's Signature: J M Hair

Evaluatee's Signature: Kevin F 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 8, Calculus-based General Physics 1 with Lab

Course Title: Calculus-based General Physics 1 with Lab

Units: 4.00

Total Instructional Hours (usually 18 per unit):	126.00
Total Student Learning Hours:	234.00
Hours per week (full semester equivalent) in Lecture:	3.00
In-Class Lab:	4.00
Arranged:	0.00
Outside-of-Class Hours	108.00

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

Cal-GETC Area:
Cal-GETC Area 5: Physical and Biological Sciences
- 5A: Physical Science
- 5C: Laboratory

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 or equivalent
Pre/Corequisite(s): None
Corequisite(s): None
Advisory(s): None

I. Catalog Description

This course is a calculus-based study of the mechanics of solids and liquids, elastic properties of matter, heat, and wave motion.

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. Physics for Scientists and Engineers: A Strategic Approach with Modern Physics, 4th , Randall Knight, Addison-Wesley © 2017, ISBN: 978-0321740908;
2. Fundamentals of Physics, 9th , D. Halliday, R. Resnick, J. Walker, Wiley © 2010, ISBN: 978-0470469118;
3. Randall Knight. Student Solutions Manual for Physics for Scientists and Engineers , Addison-Wesley , 01-12-2012
4. Randall Knight. Student Workbook for Physics for Scientists and Engineers , Addison-Wesley , 01-16-2012
5. Santa Monica College Physics Faculty . Online Laboratory Manual for Physics 8, Santa Monica College

III. Course Objectives

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

1. Understand the fundamental physical principles of elementary mechanics and thermodynamics on both a conceptual and mathematical level.
2. Explain physical phenomena qualitatively both by written and verbal means.
3. Quantitatively analyze a problem in mechanics or thermodynamics utilizing mathematical methods that include algebra, trigonometry, and elementary calculus.
4. Apply basic laboratory techniques used to demonstrate and investigate physical principles and phenomena.

IV. Methods of Presentation:

Lab, Lecture and Discussion, Observation and Demonstration, Other (Specify), Experiments, Group Work, Online instructor-provided resources
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
10.000%	Measurement, definitions of motion, vectors, and vector algebra
10.000%	Projectile and circular motion
13.000%	Impulse and momentum

13.000%	Work and energy
13.000%	Rotation and torque
10.000%	Periodic motion
10.000%	Mechanical waves, vibrating bodies and sound
7.000%	Fluid mechanics, ideal gas law
7.000%	Temperature, Heat transfer, and thermal expansion
7.000%	First and second Laws of Thermodynamics
100.000%	Total

Vb. Lab Content:

% of course	**Topic**
8.00%	Measurement
8.00%	One dimensional motion
8.00%	Vector addition
8.00%	Projectiles
8.00%	Forces
8.00%	Circular motion
8.00%	Energy
8.00%	Momentum and collisions

8.00%	Rotational inertia
8.00%	Equilibrium
8.00%	Oscillations
6.00%	String and sound waves
6.00%	Calorimetry
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 - 3-4 exams per semester
25 %	Final exam
5 %	Homework
15 %	Lab Reports - Lab Reports
100 %	Total

VII. Sample Assignments:

weekly homework sample problem:

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

A 60-kg man jumps off a platform that is 3 m high. When he lands he bends his knees so that so that his center of mass moves downward an additional 0.5 m while he is slowing to rest.

a) What is his speed when his feet first touch the ground?

b) Compare his acceleration in free-fall with his average acceleration while slowing down on the ground. Compare both magnitude and direction.

c) Draw a force diagram for the man while he is slowing down. What average force does he exert on the ground? Sketch a rough graph of the contact force vs. distance.

d) If the man locks his knees when hitting the ground, he will be brought to rest by the cushion of his shoes and his feet, which are only about 0.05 m. Determine the average force that he applies on the ground in this case.

e) Is it possible to apply a greater force on the ground than one's own weight? Why is it a good idea to bend your knees when hitting the ground?

Sample laboratory experiment: Measurement and errors:

In this experiment, students determine the density of a solid using two different measuring devices: a ruler and a Vernier caliper. Through the experiment, the students learn about error analysis and propagation of error. This sample 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 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 22, Electricity and Magnetism with Lab

Course Title: Electricity and Magnetism 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 210
Transferability
CSU/UC:
Transferability
Transfers to CSU
Transfers to UC

Cal-GETC Area:
Cal-GETC Area 5: Physical and Biological Sciences
5A: Physical Science
5C: Laboratory

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 electromagnetism covering aspects of electric and magnetic fields, DC and AC circuits, electromagnetic interactions, light, and relativity. The course is 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: 978-0135159552;
2. Physics for Scientists and Engineers, 10th, R. Serway & J. Jewett, Cengage Learning © 2018, ISBN: 978-1337553278;
3. Fundamentals of Physics, 11th, D. Halliday, R. Resnick, J. Walker, Wiley © 2018, ISBN: 978-1119286240;
4. H. Young & R. Freedman. Student Study Guide and Solutions Manual for University Physics Volume 1 (Chs 1-20), Pearson , 08-11-2011
5. H. Young & R. Freedman. Student Study Guide and Solutions Manual for University Physics Volume 2 (Chs 21-37), Pearson
6. D. Halliday, R. Resnick, J. Walker. Student Solutions Manual for Fundamentals of Physics (11th edition), Wiley
7. Santa Monica College Physics Faculty . Online Laboratory Manual for Physics 22, Santa Monica College
8. Mastering Physics . Pearson, 15th ed.
   Computer-based homework and tutorial software to accompany H. Young's and R. Freedman's University Physics.
9. WileyPLUS. Wiley, 11th ed.
   Computer-based homework and tutorial software to accompany D. Halliday, J. Resnick, and J. Walker's Fundamentals of Physics.
10. WebAssign. Cengage, 10th ed.
    Computer-based homework and tutorial software to accompany R. Serway and J. Jewett's Physics for Scientists and Engineers.

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:

Lab, Lecture and Discussion, Observation and Demonstration, Other (Specify), Experiments, Group Work

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
25.000%	Electrostatics: Charge, Force, and Coulomb's Law Electric Field and Gauss' Law Electric Potential and Energy
25.000%	Electrodynamics: Capacitance and Dielectrics Current, Resistance, and Electromotive Force DC Circuits and Instruments
20.000%	Magnetism: Magnetic Field, Force, and Torque Ampere's Law
25.000%	Electromagnetism: Electromagnetic Induction and Faraday's Law Inductance and Magnetic Materials AC Circuits Maxwell's Equations and E-M Waves
5.000%	Introduction to Special Relativity
100.000%	Total

Vb. Lab Content:

% of course	Topic
10.00%	Charge and Field
10.00%	Flux
10.00%	Equipotential Surfaces
10.00%	Oscilloscope
10.00%	Current and Resistance
10.00%	RC circuit
10.00%	Electron charge to mass ratio

10.00%	RL circuit
10.00%	RLC circuit
10.00%	AC circuits
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 - Unit Exams 55%
25 %	Final exam
5 %	Homework
15 %	Lab Reports - Laboratory 15%
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 Problem from a Typical Homework Assignment:
A coaxial cable consists of a solid inner conductor of radius a and a hollow outer conductor of inner radius b and outer radius c. The two carry equal but opposite currents, I, uniformly distributed over their cross-sectional areas.
a) Determine an expression for the magnetic-field strength, B, as a function of the radial position, r, at all distinct spatial locations.
b) Sketch a graph of the magnetic-field strength, B, as a function of the radial position, r.
c) Repeat part (a) when the outer conductor carries twice the current of the inner conductor.

Sample Laboratory Assignment:
Complete a scientific report, or inquiry-based worksheet, of the measurement of the charge-to-mass ratio of the electron. Within such a report or worksheet, a student would be required to make detailed comparisons between results that follow from basic principles and actual observations. A careful tally of experimental uncertainties within the lab and the associated propagation of errors must be exhibited to determine whether the stated observations are consistent with the theory used to model the process. In the event the results are not consistent within experimental uncertainties, various aspects should be cited that could have led to the disparity between predicted and observed results. [Please refer to

the attached file that showcases a more traditional assignment of such a laboratory exercise on the determination of the charge-to-mass ratio of the electron.]

VIII. Student Learning Outcomes

1. When presented with a physical situation and asked to solve a particular problem in, for example, electricity and magnetism (e.g., the creation of an electric current by a changing magnetic field), the student will follow a logical process based on well-established physics principles (e.g., Maxwell's equations) 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 8, CALCULUS-BASED GENERAL PHYSICS 1 WITH LAB

SPRING 2025

COURSE INFORMATION

Course Title:	PHYSICS 8, CALCULUS-BASED GENERAL PHYSICS 1 WITH LAB	
Section Number:	2885	
Units:	5.00 units	
Prerequisite(s):	MATH 7 or equivalent	
Day and Time:	Wed	08:00 AM – 11:05 PM
Location:	SCI 106	
Day and Time:	Mon, Wed	11:30 AM – 01:30 PM
Location:	SCI 140	

INSTRUCTOR INFORMATION

Instructor:	Kevin Roberts	
Email Address:	Roberts_kevin31@smc.edu	
Office Hours:	Mon	10:20–11:20AM
	Tues/Thurs	01:00–02:25PM
Location:	SCI 275	

Additional Meetings on Zoom by Appointment

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

COURSE DESCRIPTION

This course is a calculus-based study of the mechanics of solids and liquids, elastic properties of matter, heat, and wave motion.

COURSE OBJECTIVES

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

1. Understand the fundamental physical principles of elementary mechanics and thermodynamics on both a conceptual and mathematical level.
2. Explain physical phenomena qualitatively both by written and verbal means.
3. Quantitatively analyze a problem in mechanics or thermodynamics utilizing mathematical methods that include algebra, trigonometry, and elementary calculus.
4. Apply basic laboratory techniques used to demonstrate and investigate physical principles and phenomena.

STUDENT & INSTITUTIONAL 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.

REQUIRED TEXTS, MATERIALS, & SUPPLIES

1. Randall Knight, Physics for Scientists and Engineers: A Strategic Approach with Modern Physics. 4th 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 during homework assignments.
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: Mechanics, 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 (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 03/13, 04/10, and 05/15.** The exams will be 2.5 hours long and are given at the beginning of the class period.
- Final Exam: This is a cumulative exam that will be given during finals week, tentatively set for Monday 06/16 12–03 PM. It will have 15 questions chosen from the entire course.
- Lab: Labs will be held on Wednesday s. The labs that we do will be posted onto Canvas. You are expected to read the week's lab and complete the pre-lab ahead of time, so you can understand before we begin the lab. The pre-labs will be due 11:59 PM the day before the lab class. The experiments are 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 or 4. 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. Anticipate that you will require 6-10 hours to complete the homework each set. Homework will be due at **11:59 PM each Tuesday.**
- 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:**
20%	Lab Reports
5%	Homework
50%	Unit Exams
25%	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 May 16. It is NOT possible to drop the class after 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 March 02 is the last day to withdraw to Receive a Refund. Sunday, March 16 is the last day to withdraw with no grade showing on your permanent record. Sunday, May 18 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 June 16.
- **The date of the final tentatively set for Monday, 06/16 from 12–3 PM.**

MISSED AND LATE WORK

- Late homework 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.
- 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.
- Pre-lab assignments are due **the night before** the class in which the lab is assigned. No late pre-labs will be accepted.
- Labs reports are **due one week after the lab** is completed. No late lab reports will be accepted.
- Tests are mandatory and must be taken when scheduled. Under compelling circumstances with documentation, they can be made up.

EXTRA CREDIT

Extra credit may be offered at the professor's discretion.

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.
- During lab time, all group members are expected to contribute equally. Before beginning the lab, you will decide among you who will be doing which roles and write them at the top of the lab worksheet. I will be periodically checking in on everyone throughout the lab period. If you do not contribute your portion of work during a lab, you will receive a zero for that lab. If you would like help, do not hesitate to ask me BEFORE the end of the lab.

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

- During the lecture time of the class, the use of electronic devices such as laptops, and smartphones are **NOT** permitted. You may use tablets or foldable laptops with a writing surface that are face-up and in "notetaking" mode. During lab and group work time, laptops are permitted; however, to maximize participation and learning, this usage is limited to activities supporting concurrent class activities.
- Cell phones and other electronic devices should be on silent mode during class time. Put all electronics on "do not disturb" mode during class to create a good learning environment for everyone.

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.

Lab Days and Lab Reports

- We will be completing 12 labs this semester.
- Before each lab day, you must complete a pre-lab, due 11:59 PM the night before the class period. Pre-labs will be worth 20 points.
- You must show up on lab days **on time**. If you are more than 15 minutes late on lab days, you will **not** be allowed to complete the lab.
- You will complete the worksheets and turn one week later. The worksheets will be worth 100 points.
- You must use the data you gather for your lab report. You will be turning in your data you take at the end of the lab period.
- You may discuss the experiment with your lab partner and other classmates, but the lab report that you turn in must be your own work. Lab reports are subject to all the rules governing academic honesty.

Homework

- 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.
- I recommend that while you are completing the homework, you write out your reasoning: for simple conceptual questions, a couple of sentences; for longer problems full reasoning.
- 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 encourage you to work with other students to complete homework problems, you should all organize study groups.
- If you are unable to do a problem, you may discuss it with your peers, email me to ask for help (see contact information above), or go to office hours. There are also FREE tutors offer via SMC and see below for specialized services.

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 several 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 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.

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 MORNING	WEDNESDAY AFTERNOON	THURSDAY	FRIDAY
1	02-17	**PRESIDENT'S DAY HOLIDAY**		Introduction LECTURE Chapter 1.1-1.4	LECTURE Chapter 1.5-1.8		
2	02-24	LECTURE Chapter 2.1-2.4		EXP #01 Measurement and Errors LECTURE Chapter 2.5-2.6	LECTURE Chapter 3.1-3.3		
3	03-03	LECTURE Chapter 3.4 Chapter 4.1-4.2 Refund Deadline (03/02)		EXP #02 Motion of a Freely Falling Body LECTURE Chapter 4.3-4.4	LECTURE Chapter 4.4-4.6		**FLEX DAY NO CLASSES**
4	03-10	LECTURE Chapter 4.4-4.6		EXP #03 Projectile Motion	**EXAM 1 CH 1-4**		
5	03-17	LECTURE Chapter 5.1-5.4 DROP DEADLINE! (03/16 without W)		LECTURE Chapter 5.5-5.7	LECTURE Chapter 5.5-5.7	**FLEX DAY NO CLASSES**	
6	03-24	LECTURE Chapter 6.1-6.3		EXP #04 Dynamics of Circular Motion LECTURE Chapter 6.4-6.6	LECTURE Chapter 6.4-6.6	Chapter 11.6	
7	03-31	LECTURE Chapter 7.1-7.3		EXP #05 Newton's Laws LECTURE Chapter 7.4-7.5 Chapter 8.1	LECTURE Chapter 8.2-8.4		
8	04-07	LECTURE Chapter 8.5 Chapter 9.1-9.4		**EXAM 2 CH 5-8** LECTURE Chapter 9.5-9.6 Chapter 10.1-10.4	LECTURE Chapter 10.5-10.8	Chapter 12.3-12.6	

9	04-14	**CESAR CHAVEZ DAY SPRING BREAK**	**SPRING BREAK**	**SPRING BREAK FLEX DAY**	**SPRING BREAK FLEX DAY**	**SPRING BREAK FLEX DAY**	**SPRING BREAK FLEX DAY**
10	04-21	LECTURE Chapter 11.1-11.4		EXP #06 Momentum and Collisions LECTURE Chapter 11.4-11.6	LECTURE Chapter 12.1-12.6		
11	04-28	LECTURE Chapter 12.7-12.12	Chapter 12.10-12.12	EXP #07 Torque and Moment of Inertia LECTURE Chapter 13.1-13.4	LECTURE Chapter 13.4-13.6		
12	05-05	LECTURE Chapter 14.1-14.3		EXP #08 Physical Pendulum LECTURE Chapter 14.4-14.6	LECTURE Chapter 15.1-15.6		
13	05-12	LECTURE Chapter 15.7-15.8 Chapter 16.1-16.5		EXP #09 Archimedes' Principle and Buoyancy LECTURE Chapter 16.6-16.9	**EXAM 3 CH 11-16**		
14	05-19	LECTURE Chapter 17.1-17.5 DROP DEADLINE! (05/16 with W)		EXP #10 Frequency of Transverse Standing Waves LECTURE Chapter 17.4-17.6	LECTURE Chapter 17.7-17.8 Chapter 18.1-18.5		
15	05-26	**MEMORIAL DAY HOLIDAY**		EXP #11 Latent Heat of Fusion of Ice LECTURE Chapter 18.5-18.7	LECTURE Chapter 19.1-19.4		
16	06-02	LECTURE Chapter 19.5-19.8 Chapter 20.1-20.3		EXP #12 Statistical Nature of Entropy LECTURE Chapter 20.4-20.6	LECTURE Chapter 21.1-21.3		
17	06-09	LECTURE Chapter 21.4-21.6 Review	FINAL EXAM WEEK	FINAL EXAM WEEK	FINAL EXAM WEEK	FINAL EXAM WEEK	FINAL EXAM WEEK
18	06-16	**FINAL EXAM 12–3 PM (Tentative)** REQUEST P/NP DEADLINE!	FINAL EXAM WEEK				

PHYSICS 22, ELECTRICITY AND MAGNETISM WITH LAB

SPRING 2025

COURSE INFORMATION

Course Title:	PHYSICS 22, ELECTRICITY AND MAGNETISM WITH LAB
Section Number:	2961
Units:	5.00 units
Prerequisite(s):	MATH 8 or equivalent PHYSICS 21
Day and Time:	Mon 02:30 PM – 04:30 PM
Location:	SCI 122
Day and Time:	Tues, Thurs 02:30 PM – 05:00 PM
Location:	SCI 122

INSTRUCTOR INFORMATION

Instructor:	Kevin Roberts	
Email Address:	Roberts_kevin31@smc.edu	
Office Hours:	Mon	10:20–11:20AM
	Tues/Thurs	01:00–02:25PM
Location:	SCI 275	

Additional Meetings by Appointment

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

COURSE DESCRIPTION

This course is a calculus-based study of electromagnetism covering aspects of electric and magnetic fields, DC and AC circuits, electromagnetic interactions, light, and relativity. The course is intended for engineering and physical science students.

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, for example, electricity and magnetism (e.g., the creation of an electric current by a changing magnetic field), the student will follow a logical process based on well-established physics principles (e.g., Maxwell's equations) 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 during homework assignments.
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: Electricity and Magnetism, Volume 2

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 03/13, 04/10, and 05/15.** The exams will be 1.25 hour long and are given at the beginning of the class period.
- Final Exam: This is a cumulative exam that will be given during finals week, tentatively set for Thursday 06/12 12–03 PM. It will have 15 questions chosen from the entire course.
- Lab: Labs will be held on Tuesdays and Thursdays. The labs that we do will be posted onto Canvas. You are expected to read the week's lab and complete the pre-lab ahead of time, so you can understand before we begin the lab. The pre-labs will be due 11:59 PM the day before the lab class. The experiments are 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 2 or 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. Anticipate that you will require 6-10 hours to complete the homework each set. Homework will be due at **11:59 PM each Tuesday.**
- 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:
20%	Lab Reports
5%	Homework
50%	Unit Exams
25%	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 May 16. 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 March 02 is the last day to withdraw to Receive a Refund. Sunday, March 16 is the last day to withdraw with no grade showing on your permanent record. Sunday, May 18 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 Tuesday June 17.
- **The date of the final is tentatively set for Thursday, 06/12 from 12–3 PM.**

MISSED AND LATE WORK

- Late homework 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.
- 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.
- Pre-lab assignments are due **one hour before** the class in which the lab is assigned. You must show up on lab days **on time**. If you are more than 15 minutes late on lab days, you will **not** be allowed to complete the lab
- Labs reports are **due one week after the lab** is completed. No late lab reports will be accepted.
- Tests are mandatory and must be taken when scheduled. Under compelling circumstances with documentation, they can be made up.

EXTRA CREDIT

Extra credit may be offered at the professor's discretion.

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.
- During lab time, all group members are expected to contribute equally. Before beginning the lab, you will decide among you who will be doing which roles and write them at the top of the lab worksheet. I will be periodically checking in on everyone throughout the lab period. If you do not contribute your portion of work during a lab, you will receive a zero for that lab. If you would like help, do not hesitate to ask me BEFORE the end of the lab.

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

- During the lecture time of the class, the use of electronic devices such as laptops, and smartphones are **NOT** permitted. You may use tablets or foldable laptops with a writing surface that are face-up and in "notetaking" mode. During lab and group work time, laptops are permitted; however, to maximize participation and learning, this usage is limited to activities supporting concurrent class activities.
- Cell phones and other electronic devices should be on silent mode during class time. Put all electronics on "do not disturb" mode during class to create a good learning environment for everyone.

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.

Lab Days and Lab Reports

- We will be completing 12 labs this semester.
- Before each lab day, you must complete a pre-lab, due one hour before the class period. Pre-labs will be worth 20 points.
- You must show up on lab days **on time**. If you are more than 15 minutes late on lab days, you will **not** be allowed to complete the lab.
- You will complete the worksheets and turn one week later. The worksheets will be worth 100 points.
- You must use the data you gather for your lab report. You will be turning in your data you take at the end of the lab period.
- You may discuss the experiment with your lab partner and other classmates, but the lab report that you turn in must be your own work. Lab reports are subject to all the rules governing academic honesty.

Homework

- 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.

- I recommend that while you are completing the homework, you write out your reasoning.
- 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 encourage you to work with other students to complete homework problems, you should all organize study groups.
- If you are unable to do a problem, you may discuss it with your peers, email me to ask for help (see contact information above), or go to office hours. There are also FREE tutors offer via SMC and see below for specialized services.

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 several 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 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.

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	02-17	**PRESIDENT'S DAY HOLIDAY**	Introduction LECTURE Chapter 21.1-21.3		LECTURE Chapter 21.4-21.6 EXP #01 Electric Charge and Field	
2	02-24	LECTURE Chapter 21.7 Chapter 22.1-22.2	LECTURE Chapter 22.3-22.4		LECTURE Chapter 22.4-22.5 EXP #02 Electric Flux	
3	03-03	LECTURE Chapter 23.1-23.2 Refund Deadline (03/02)	LECTURE Chapter 23.3-23.4		LECTURE Chapter 23.5 EXP #03 Equipotential Surfaces and Lines of Force	**FLEX DAY** **NO CLASSES**
4	03-10	LECTURE Chapter 24.1-24.2	CATCH-UP DAY		**EXAM 1 CH 21-23** LECTURE Chapter 24.3	
5	03-17	LECTURE Chapter 24.4-24.5 DROP DEADLINE! (03/16 without W)	LECTURE Chapter 24.6 EXP #04 The Oscilloscope		**FLEX DAY** **NO CLASSES**	
6	03-24	LECTURE Chapter 25.1-25.3	LECTURE Chapter 25.4-25.5		LECTURE Chapter 25.5-25.6 EXP #05 Resistivity and Ohm's Law	
7	03-31	LECTURE Chapter 26.1-26.2	LECTURE Chapter 26.3-26.4		LECTURE Chapter 26.5 EXP #06 DC Circuits	
8	04-07	LECTURE Chapter 27.1-27.2	CATCH-UP DAY		**EXAM 2 CH 24-26**	

9	04-14	**CESAR CHAVEZ DAY** **SPRING BREAK**	**SPRING BREAK**	**SPRING BREAK FLEX DAY**	**SPRING BREAK FLEX DAY**	**SPRING BREAK FLEX DAY**
10	04-21	LECTURE Chapter 27.3-27.5	LECTURE Chapter 27.6-27.7 EXP #07 RC Circuit		LECTURE Chapter 27.8-27.9	
11	04-28	LECTURE Chapter 28.1-28.3	LECTURE Chapter 28.4-28.5 EXP #08 Magnetic Fields		LECTURE Chapter 28.6	
12	05-05	LECTURE Chapter 28.7-28.8	LECTURE Chapter 29.1-29.3 EXP #09 Measurement of e/m		LECTURE Chapter 29.4-29.5	
13	05-12	LECTURE Chapter 29.6-29.8	CATCH-UP DAY LECTURE Chapter 30.1-30.2		**EXAM 3 CH 27-29**	
14	05-19	LECTURE Chapter 30.3-30.4 DROP DEADLINE! (05/16 with W)	LECTURE Chapter 30.5-30.6 EXP #10 RL Circuits		LECTURE Chapter 31.1-31.3	
15	05-26	**MEMORIAL DAY HOLIDAY**	LECTURE Chapter 31.4-13.6 EXP #11 RLC Circuits		LECTURE Chapter 32.1-32.2	
16	06-02	LECTURE Chapter 32.3-32.4	LECTURE Chapter 32.5 Chapter 37.1-2 EXP #12 AC Circuits		LECTURE Chapter 37.3-37.6	
17	06-09	LECTURE Chapter 37.7-37.9 Review	FINAL EXAM WEEK	FINAL EXAM WEEK	**FINAL EXAM 12–3 PM (Tentative)**	FINAL EXAM WEEK
18	06-16	FINAL EXAM WEEK	FINAL EXAM WEEK REQUEST P/NP DEADLINE!			

Kevin Roberts's Plan for Professional Development Spring 2025 (5/28/2025)

My name is Kevin Roberts and I'm undergoing the tenure process at SMC for the position of physics professor. For continuing professional development, I'm updating my plan for professional development for Spring 2025.

Last Fall 2024 was a rough semester. I took on too many responsibilities, subbing for too many colleagues while having my own responsibilities fall. I fell catastrophically behind in grading exams, grading them all in the last few weeks. And I also couldn't develop good rubrics because I was rushing. That can never be repeated. It is not good for me; I was constantly burnt out and my students didn't get feedback on where they stood in the class. A quite a few were surprised when they got a B in the class after they got their grades back. My personal commitment is that will grade all major assessments, like exams, within 2 weeks of giving them. So, this semester, I limited outside commitments this semester to only the Curriculum Committee.

This current semester, Spring 2025, I returned Exam 1 very quickly, within a week of giving them to each class. However, when exam 2 came, I didn't meet my commitment. Partly due to students coming in with crises: food poisoning, severe menstrual cramps, hospitalization for domestic violence, and mandatory hospitalization for a suicide attempt, among others, I kept delaying the grading of the exams. That is not fair to the other students in my classes. They deserve the feedback on their work in a timely manner, so they can learn from their mistakes and do better on following assessments. Once I finally set my priority was to grade the exams, I was able to develop detailed rubrics and finish grading in a timely manner. I estimate that each exam of about 22/25 students (for each class) took about 8-10 hours to grade over several days. As Forouzan recommended, I want to write out my rubrics ahead of time (with the possibility of tweaking them if I need to afterward).

For the assessments themselves, based on what I saw last semester and this one, I like the shift I made this semester. I gave more challenging assessments and that created a broad distribution to analyze. For now, I will continue this level of difficulty of exams with the assumption that I will curve the exams. I have added more questions and increased the time I give to each exam. By giving more rigorous and varied questions on exams, I can better assess which students earned A's, B's, and C's in my classes. Eventually in the future, I think I will tapper the difficulty of the exams only slightly, as my goal is the median score for each exam be between 75 and 80; I will err on the side of a tougher exam, because curving can give me a cushion. My rubrics are now much stricter too. I am doing positive scoring, and with very specific points and steps performed. This means my scores on the exams are lower, but are very specific in what a student missed so they can improve. And that specificity has reduced students request for regrading. I had only one student as about one rubric point on an exam so far, and I subsequently clarified that rubric point. Last semester, I had been unintentionally "pre-curving" with the loose rubrics, which brought me out of alignment with the grade distribution for the rest of the department. Along with prompt grading, I commit working on this over the next year

Compared to previous semesters, I have greatly reduced the number of assignments in my classes. I think this has massively improved the tenor of the class and more workload. Students

aren't constantly asking for extensions for various assignment. Just a weekly online homework that is automatically graded, and (nearly) weekly lab reports. For now, I don't think I will be introducing any other out-of-class assignments besides what I currently have. And any in-class assignments I will reintroduce, that I detail later, I will have them be automatically graded, multiple-choice.

My lab presentation has much improved over last year. I have now limited the total number of groups to 7. This has greatly improved lab management because now I can better keep an eye on the 7 groups, rather than the 10 I sometime had in the past. And I don't have to chase down the parts as much because we have backups and spares (At the same time, I do believe that many of our labs need significant equipment replacement or updating). I now set my boundary firmly on lab days, no one that enters 15 minutes after the start of my pre-lecture can do lab, and after a little surprise students have respected that. As Emin noticed last semester, students were taking advantage of the long pre-lab lecture and the lack of a policy that prevented student from showing up very late. I have mostly kept my pre-lab presentations limited to 15 minutes, as a correction to the lengthy lectures I gave before. Last semester, I was worried that students would come back with faulty data and not realize until 10 minutes before the end of class or the next day, so I talk for a longer time than I need to. Depending on the lab, I lecture a bit more about the nuances of the data taking that you can only see in person. The analysis of data, where students check their work, I'll be moving into at-home pre-labs or excel spreadsheets that I provide them.

This semester I've changes the way I have had student prepare for the data analysis. As in the past, I have my student use Excel to perform their analysis. I can more quickly diagnose issues if I can spot the problem in their work immediately in a spreadsheet. In the past, I had students create a file along with me as part before they started on lab day. This took way too much time away from data-taking. So I shifted this into two possibilities: either they would set up an Excel spreadsheet themselves with a pre-lab I created, or they would use Excel spreadsheet that I created with formulas that they could edit. For the first weeks, I developed some pre-labs that I'm very proud of and I'll continue to reuse. Across of the labs in the physics class, I think the pre-labs are underdeveloped. For example, the pre-lab for the first lab for Physics 6/8/21 is a single question "If you have a cylinder of an unknown material, how can you determine what it is made up of if you only have a scale and a ruler?" While a fine question, I think the students aren't fully prepared to start the lab by answering this question. When I had time (before I gave their first exams), I created a whole step-by-step procedure where they took simulated data diagrams I created with scales, rulers, and calipers and created an Excel spreadsheet that was ready before they came to class. This way, they will be able to check their work as they do the lab and hopefully catch errors sooner. And most the labs for Physics 22 don't have pre-labs at all. I was only able to develop pre-labs for the first couple before I had other parts have higher priority. When I have more time I will develop more pre-labs to add to the lab manual. One new thing I notice with our new oscilloscopes, we can very easily export data to excel with a USB drive. This made data analysis for the oscilloscope-based labs much more robust. I want to edit our current labs to accommodate this change.

Compared to last semester, I have refined my lesson plans. I now have full sets of notes for Physics 21, 22, 23, and (soon to be complete) 8. These lecture notes with figures students either print out or download ahead of time. Then as a class, I go over them and add my notes on

top of them. I've become very comfortable using to present lecture notes on my iPad projected on a screen. One note to myself keep typing to a minimum or writing long series of sentences to a minimum. If there is a point that requires that amount of text, I will include it as part of my lecture template to improve my lecture flow and then annotate on top of it. After experimenting with a variety of projecting my iPad, in the last few weeks I've found a method that works great for me. I screencast my iPad to my laptop, which then is connected to the projector. The laptop doesn't need to move because some of the VGA connectors are very short (which was an issue when I was directly connecting my iPad to the VGA connection). Screen casting gives me freedom to walk around and engage with my students as I write on my iPad. I've gone in front of the desk and became more active in my presentation. The next step I want to be is to trust that I can be "off book" from my own notes and expand on the lecture notes that I have adapted. I still need to work on streamline the notes for course like Physics 6/7 and 8/9 that cover a larger breadth of subjects than the 20 series. For in-class examples that I cover, I often draw on examples that are covered in the assigned textbook for the class. In the future, I want to cover different examples than the textbook, either by drawing on different sources or developing my own that way I won't double up the book. When students ask me off-topic questions that are very common and excite them, I want to clearly state: "this 5-minute detour won't be on the test" and then clearly signpost when I'm back on lecture.

I think the way I have implemented group work more seamlessly works into my lecture better than before. Rather than the 4-5 question handouts where everyone broke up into groups, interrupting the flow of the lecture (and were time-consuming to grade rigorously). I now just have a multiple-choice question that connects to what I'm talking about. I encourage my students to discuss with each other about each question. However, I'm not taking any data from the students, so it has been optional and a few of my students zone out (or don't show up to lecture at all); to correct this, I will make it mandatory again. I'll have it be multiple choice for quick assessment (either a conceptual or quick calculation) with 3 points total per question: 2 for participation, 1 for the correct answer. If I teach in a big lecture hall again, I'll have students sit in the front half. This will limit the daydreaming or goofing off in the back and encourage students to work together and get to know each other.

I am also proud of the work that I have done on the Curriculum Committee. I have learned the ins and outs of how this committee works. This semester, I helped guide the Chemistry Technician Certificate of Achievement and SLO/PLO mappings for the Engineering degree and Certificate of Achievement. Whereas many other departments had their proposals bogged down when errors were caught or were tripped up imprecise language, our proposal sailed through the committee within 5 minutes total! I can only think of a few other times that has happened before. I made sure to run our proposals by some of the "power players" of the committee so we wouldn't be surprised. And along with reading the agendas for each week so that I'm prepared, I've kept this commitment manageable to 1-2 hours of prep for 1-2 hours meeting every other week. Next, we will have the Physics ADT that I developed with the help of Emin pass through the committee next. Eventually, I'd want to develop more Certificates of Achievement so that our department is more ready for when SMC switches the success funding model. I'll ask around our department to see if anyone has ideas.

Lastly, I'll be preparing our department for the Common Course Numbering (CCN). I'll let other faculty take the leads on implementing the templates as they see fit. I think they might take this opportunity to update the course outlines of record for these class. For this, I'll merely be a facilitator so the process can happen as smooth as possible. My goal is to have the CCN updates sail through like my proposals did this semester!

HSIEH_JENNIFER

From: HSIEH_JENNIFER
Sent: Tuesday, March 11, 2025 1:42 PM
To: ROBERTS_KEVIN31
Cc: FARIDIAN_FOROUZAN; MENACHEKANIAN_EMIN
Subject: Fall 2024, Exam grading clarification questions

Hi Kevin,

Thanks for the discussion earlier today. I wanted to get some more clarification on how you graded the midterms from last semester. I just looked the first person on the Physics 23 list – Bryan Bae.

For exam 1, when I click on cell B1, I can see the formula showing "=18+17+18+17+14" equals 84 I'm assuming that each number in the summation corresponds to the points earned on problems 1, 2, 3, 4, 5.

For exam 2, similarly in cell D2 the formula shows "=20+20+14+18+19" equals 91.

Exam 3, there is no formula. It's just the number "95"

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Department Chair, Physical Sciences
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HSIEH_JENNIFER

From: ROBERTS_KEVIN31
Sent: Wednesday, March 12, 2025 4:31 PM
To: HSIEH_JENNIFER
Cc: FARIDIAN_FOROUZAN; MENACHEKANIAN_EMIN
Subject: Re: Fall 2024, Exam grading clarification questions
Attachments: Exam_2_Jun_Keon_Cho.pdf; Exam_2_Kevin_Kim.pdf; Exam_2_Samuel_Fisher.pdf; Exam_2_Taber_Schreiber.pdf; Exam_2_Tyler_Hall.pdf; Rubric for Exam 2 FA24.docx

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Rubric for Exam 2 FA24

1.

Part a	part b
+3.0 Use $pV = nRT$ to calculate the number of moles	+5.0 Find the number of molecules in 1 cm^3 at 1 atm
+3.0 Use $N = nN_A$ to calculate the number of molecules	+2.5 some attempt
-1.0 calc error	-0.5 missing units
-0.5 missing units	

2.

+20 points	correct
+17 points	very good
+15 points	good
+12 points	fair
+8 points	some attempt
+4 points	set up equations

3.

+20 points	correct
+17 points	very good
+15 points	good
+12 points	fair
+8 points	some attempt
+4 points	set up equations

4.

+20 points	correct
+17 points	very good
+15 points	good
+12 points	fair
+8 points	some attempt
+4 points	set up equations

5.

+20 points	correct
+17 points	very good
+15 points	good
+12 points	fair
+8 points	some attempt
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HSIEH_JENNIFER

From: HSIEH_JENNIFER
Sent: Wednesday, March 19, 2025 11:26 AM
To: ROBERTS_KEVIN31
Cc: FARIDIAN_FOROUZAN; MENACHEKANIAN_EMIN
Subject: RE: Fall 2024, Exam grading clarification questions

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Regarding the rubric, I reviewed the document attached to this email and it provides no greater clarity than what you shared in our meeting. For questions 2 – 5, you listed:

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From: ROBERTS_KEVIN31
Sent: Friday, March 21, 2025 4:45 PM
To: HSIEH_JENNIFER
Cc: FARIDIAN_FOROUZAN; MENACHEKANIAN_EMIN
Subject: Re: Fall 2024, Exam grading clarification questions
Attachments: Exam 2 Grading rubric.docx

Follow Up Flag: Follow up
Flag Status: Flagged

Hi everyone,

Here is a more thorough rubric with examples of each level of the question. Let me know if you would like more context on this.

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Exam 2 Grading rubric:

1.

Part a: Use $PV = nRT$ (+3)

Use: $N = nN_A$ to find molecules (+3)

Part b: find number of molecules $N_2 = p_2 \frac{N_1}{p_1}$ or equivalent methods (+5)

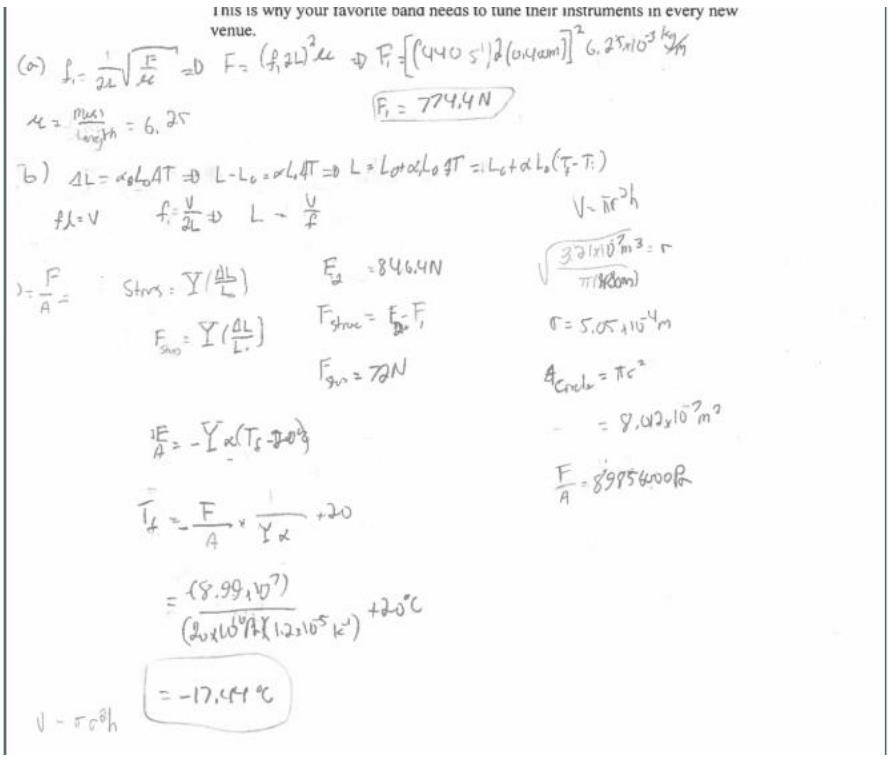
Part c: find the pressure in the nebula (+3)

find the ratio of pressures $\frac{p_{neb}}{p_{lab}}$ (+3)

part d: correctly note that the nebula's pressure is far too small to create turbulence. (+3)

2. Tension in wire:

+20 points correct


This is why your favorite band needs to tune their instruments in every new venue.

(a) $f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}} \Rightarrow F = (f_1 2L)^2 \mu \Rightarrow F_1 = [(440\ s^{-1})2(0.4\,cm)]^2\, 6.25\times10^{-3}\,kg$

$\mu = \frac{mass}{length} = 6.25$

$F_1 = 774.4\,N$

b) $\Delta L = \alpha_0 L_0 \Delta T \Rightarrow L - L_0 = \alpha_0 L_0 \Delta T \Rightarrow L = L_0 + \alpha_0 L_0 \Delta T = L_0 + \alpha L_0 (T_f - T_i)$

$fL = V \quad f_1 = \frac{V}{2L} \Rightarrow L = \frac{V}{f}$

$V = \pi r^2 h$

$\sqrt{\frac{3.21\times10^{-7}\,m^3}{\pi(8\,cm)}} = r$

$r = 5.05\times10^{-4}\,m$

$A_{circle} = \pi r^2$

$= 8.02\times10^{-7}\,m^2$

$\frac{F}{A} = 8985400\,Pa$

$\sigma = \frac{F}{A} =$ Stress $= Y(\frac{\Delta L}{L})$

$F_{stress} = Y(\frac{\Delta L}{L})$

$F_2 = 846.4\,N$

$F_{stress} = F_2 - F_1$

$F_{stress} = 72\,N$

$\frac{F}{A} = -Y\alpha(T_f - 20°C)$

$T_f = -\frac{F}{A} \times \frac{1}{Y\alpha} + 20$

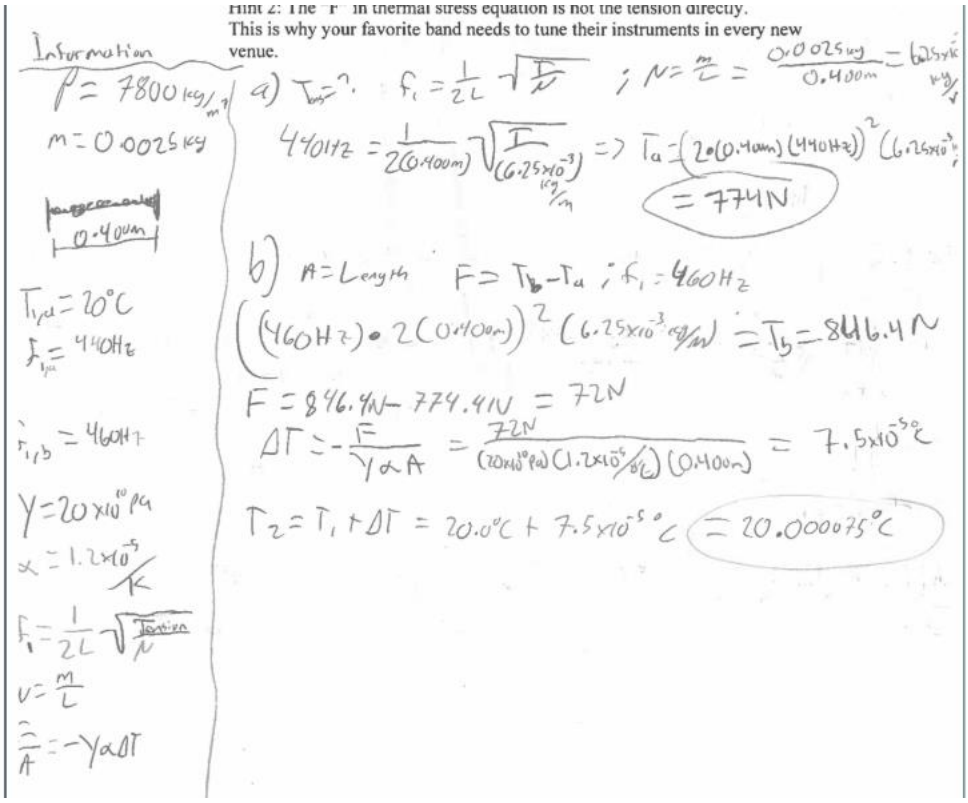
$= \frac{(8.99\times10^7)}{(2\times10^{10}\,Pa)(1.2\times10^{-5}\,K^{-1})} + 20°C$

$= -17.44\,°C$

$V = \pi r^2 h$

This student got the correct answer.

+17 points very good



Hint 2: The "F" in thermal stress equation is not the tension directly.
This is why your favorite band needs to tune their instruments in every new venue.

Information

$\rho = 7800\ kg/m^3$

$m = 0.0025\ kg$

0.400m

$T_{1,a} = 20°C$

$f_{1,a} = 440Hz$

$f_{1,b} = 460Hz$

$Y = 20\times10^{10}\ Pa$

$\alpha = 1.2\times10^{-5}/K$

$f_1 = \frac{1}{2L}\sqrt{\frac{Tension}{\mu}}$

$\mu = \frac{m}{L}$

$\frac{F}{A} = -Y\alpha\Delta T$

a) $T_a = ?$ $f_1 = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$; $\mu = \frac{m}{L} = \frac{0.0025\ kg}{0.400m} = 6.25\times10^{-3}\ kg/m$

$440Hz = \frac{1}{2(0.400m)}\sqrt{\frac{T}{(6.25\times10^{-3}\ kg/m)}} \Rightarrow T_a = (2(0.400m)(440Hz))^2(6.25\times10^{-3}\ kg/m)$

$= 774N$

b) $A = Length$ $F = T_b - T_a$; $f_1 = 460Hz$

$((460Hz)\cdot 2(0.400m))^2(6.25\times10^{-3}\ kg/m) = T_b = 846.4N$

$F = 846.4N - 774.4N = 72N$

$\Delta T = -\frac{F}{Y\alpha A} = \frac{72N}{(20\times10^{10}Pa)(1.2\times10^{-5}/°C)(0.400m)} = 7.5\times10^{-5}°C$

$T_2 = T_1 + \Delta T = 20.0°C + 7.5\times10^{-5}°C = 20.000075°C$

This student got part a correct and found the new tension for part b. They understood that the thermal stress equation required a difference in tension. They made a calculator error after setting up the thermal stress equation, and misunderstood that the temperature needs to drop for an increase in tension.

+15 points good

a. $440 = \frac{v}{2(0.4)}$ $v = 352 \frac{m}{s}$ $v = \sqrt{\frac{T}{\mu}}$ $352 = \sqrt{\frac{T}{\frac{0.0025\,kg}{0.4\,m}}}$

$\boxed{T = 774.4\,N}$

b. $460 = \frac{v}{0.8} = v = 368 \frac{m}{s}$ $368 = \sqrt{\frac{T}{\frac{0.0025\,kg}{0.4\,m}}} = T = 846.4\,N$

$4\pi r^2$ $\underline{846.4\,N}$

$V = \pi r^2 h$

$\pi r^2 (0.4m) = 3.21 \times 10^{-7} m^3$

$\frac{0.0025\,kg}{7800\,\frac{kg}{m^3}} = 3.21 \times 10^{-7} m^3$

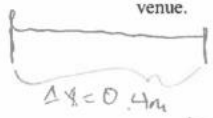
$r = 5 \times 10^{-4} m$

$\frac{846.4}{4\pi(5\times10^{-4})^2} = -(20\times10^{10} Pa)(1.2\times10^{-5})(\Delta T$

This student got part a correct and found the new tension for part b. They also tried setting up the thermal stress equation, but were unsuccessful.

+12 points fair

venue.



$\rho_{steel} = 7800 \frac{kg}{m^3}$ $m = 2.5g = 0.0025\ kg$

a) $v = \sqrt{\frac{T}{\sigma}}$ $v = \lambda f$ $L = \frac{\lambda}{2} \Rightarrow \lambda = 2L$

$v = (0.8m)(440Hz)$ $\lambda = 0.8m$

$v^2 = \frac{T}{\sigma}$

$v = 352 \frac{m}{s}$

$T = \sigma v^2$

$\sigma = \frac{m}{L} = \frac{0.0025kg}{0.4m} = \frac{1}{160} \frac{kg}{m}$

$T = (\frac{1}{160} \frac{kg}{m})(352 \frac{m}{s})^2$

$T = 774.4N$

b) $\sigma_{stress} = E\alpha\Delta T$

$\Delta T = \frac{\sigma_{stress}}{E\alpha}$ $\sigma_{stress} = \frac{\sigma(\lambda f)^2}{L}$ $= \frac{\frac{1}{160}((0.8m)(440Hz))}{0.4m}$

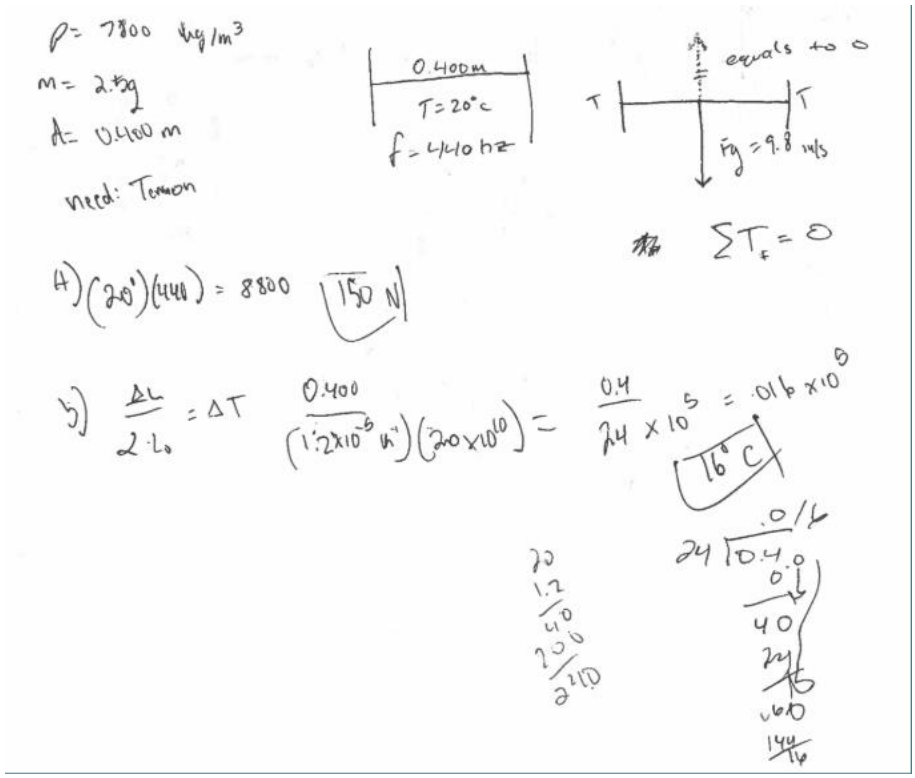
$= \frac{(20\times10^{10} Pa)(1.2\times10^{-5}\frac{1}{K})}{846400}$ $\sigma_{stress} = 846400$

$\Delta T = 2.836°C$

the final tem will be $20°C + 2.836°C = 22.836°C$

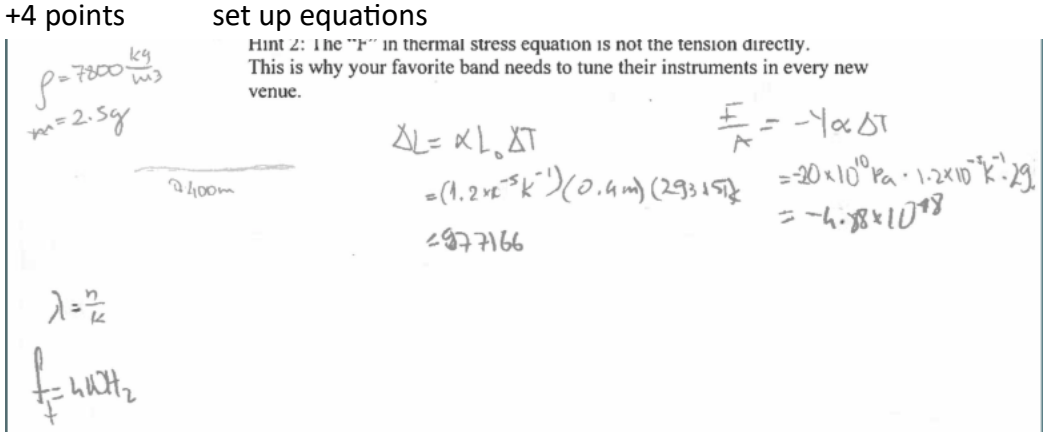
This student understood the need to find the tension (correctly for part a) and the need to apply thermal tension equation but didn't understand that an increase in temperature would result in decrease in tension. They didn't find the new tension.

+8 points some attempt



This student calculated a tension and a temperature but didn't consider how the two parts of the question were related.

+4 points set up equations



This student set up the correct equations, but didn't make much progress beyond setting them up.

3.

+20 points correct

a) $R = \frac{l}{K}$

$$R_{wood} = \frac{l_{wood}}{K_{wood}} = \frac{3\times10^{-2}}{8\times10^{-2}} = 0.375 \ \frac{m^2.K}{W}$$

$$R_{styrofoam} = \frac{l_{sty}}{K_{sty}} = \frac{2.2\times10^{-2}}{2.7\times10^{-2}} = 0.81 \ \frac{m^2.K}{W}$$

$$H = \frac{KA(T_H - T_C)}{l} = \frac{A(T_H - T_C)}{R}$$

$H_w = H_{sty}$ (the area of the surface is same for both)

$$\frac{\cancel{A}(T_H - T_C)}{l_w} = \frac{\cancel{A}(T_H - T_C)}{l_{sty}}$$

$$\frac{T - (-10)}{0.375} = \frac{19 - T}{0.81}$$

$$0.81T + 8.1 = 7.125 - 0.375T$$

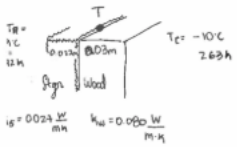
$$1.185T = -0.975$$

$$T = -0.82 \ °C$$

b) $\frac{H}{A} = \frac{T_H - T_C}{R} = \frac{-0.82 + 10}{0.375} = 24.48 \ \frac{W}{m^2}$

This student got the correct answer.

+17 points very good



Conduction

wood? the whole thing.

a) $H = \frac{dQ}{dt} = kA\frac{T_H - T_c}{L}$

$H_{styr} = H_w$

$k_s \cancel{A} \frac{T_s - T}{\cancel{L}} = k_w \cancel{A} \frac{T - T_w}{\cancel{L}}$

$k_s(T_s - T) = k_w(T - T_w)$

$k_s T_s - k_s T = k_w T - k_w T_w$

$k_s T_s + k_w T_w = k_w T + k_s T$

$T = \frac{k_s T_s + k_w T_w}{k_w + k_s}$ $T_s = 292K$ $T_w = 263K$

$T = 270K$

$\boxed{T_{middle} = -2.69°C}$

b) $H = \frac{dQ}{dt} = k_{total} A \frac{T_H - T_c}{L} = k_{total} \cdot \frac{T_H - T_c}{L}$ per m^2

$= k_{total} \frac{(19 - (-10))}{(0.027 + 0.03)}$

$= k_{total} \left(\frac{29}{0.052}\right)$

$H = k_{total}(557.69)$

$H = k_s \cdot 557.69$

$\boxed{H = 15\ W}$

This student set up the correct equations and made the correct steps on the process but confused some numbers along the way.

+15 points good

6. What is the rate of heat flow per square meter through this wall?

$k_{wood} = 0.060 \frac{W}{m \cdot K}$

$k_{styro} = 0.027 \frac{W}{m \cdot K}$

$T_{int} = 19°C \rightarrow 292.15K$

$T_{ext} = -10°C \rightarrow 263.15K$

(a.)

$$k_{wood}(T_{board} - T_{ext}) = k_{styro}(T_{int} - T_{board})$$

$$k_{wood} T_{board} - k_{wood} T_{ext} = k_{styro} T_{int} - k_{styro} T_{board}$$

$$k_{wood} T_{board} + k_{styro} T_{board} = k_{styro} T_{int} + k_{wood} T_{ext}$$

$$T_{board} = \frac{k_{styro} T_{int} + k_{wood} T_{ext}}{k_{wood} + k_{styro}}$$

$$= \frac{0.027 \frac{W}{m \cdot K}(292.15K) + (0.08 \frac{W}{m \cdot K})(263.15)}{0.027 \frac{W}{m \cdot K} + 0.08 \frac{W}{m \cdot K}}$$

$$T_{board} = 270.4677K$$

(b)

$$\frac{dQ}{dm^2} = \Delta T \cdot \left(\frac{k_{wood}}{0.022m} + \frac{k_{styro}}{0.003m}\right)$$

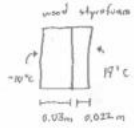
$$= (270.4677K)\left(0.027 \frac{W}{m \cdot K} + 0.08 \frac{W}{m \cdot K}\right)$$

$$\frac{dQ}{dm^2} = 1157.6016 \frac{W}{m^2}$$

Had a good attempt at part a, but became confused for how to properly solve part b

+12 points fair

$$H = kA\left(\frac{T_H - T_C}{L}\right) \qquad R = \frac{L}{k}$$



$$K_C = -10 + 273 = 263\ K$$

$$K_H = 19 + 273 = 292\ K$$

a. $$k_w \cancel{A}\left(\frac{T_M - T_C}{L}\right) = k_s \cancel{A}\left(\frac{T_H - T_M}{L}\right)$$

$$\frac{k_w}{L_w}(T_M - T_C) = \frac{k_s}{L_s}(T_H - T_M)$$

$$\frac{k_w}{L_w}T_M - \frac{k_w}{L_w}T_C = \frac{k_s}{L_s}T_H - \frac{k_s}{L_s}T_M$$

$$\frac{k_w}{L_w}T_M + \frac{k_s}{L_s}T_M = \frac{k_s}{L_s}T_H + \frac{k_w}{L_w}T_C$$

$$T_M\left(\frac{k_w}{L_w} + \frac{k_s}{L_s}\right) = \frac{k_s}{L_s}T_H + \frac{k_w}{L_w}T_C$$

$$T_M = \frac{\frac{k_s}{L_s}T_H + \frac{k_w}{L_w}T_C}{\frac{k_w}{L_w} + \frac{k_s}{L_s}}$$

$$\boxed{T_{middle} = \frac{\left(\frac{292 \cdot 0.027}{0.022}\right) + \left(\frac{263 \cdot 0.080}{0.03}\right)}{\left(\frac{0.080}{0.03}\right) + \left(\frac{0.027}{0.022}\right)}}$$

b. $$\boxed{H = \left(\frac{0.080}{0.03}\right)(29)}$$

Got part a correct, and had an idea of how to set up part b, but were unsuccessful.

+8 points some attempt

b. What is the rate of heat flow per square meter through this wall?

$417.93 = (1m^2)(1)(5.67\times10^{-8}\frac{W}{K^4m^2})(T^4)$

$7362081129 = T^4$

$T = 292.95\ K$

$=$

b. $\frac{dQ}{dt} = 0.08(1m^2)(\frac{19+10}{0.003m}) = 773.33\ W$

$\frac{dQ}{dt} = 0.027(1m^2)(\frac{19+10K}{0.0022m}) = 355.9\ W$

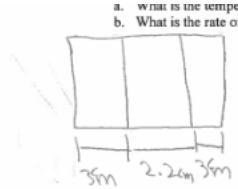
$= \boxed{417.43\ W}$

This student attempted to apply the equations, but didn't show much understanding of how they should be properly used.

+4 points set up equations

a. What is the temperature at the plane where the wood meets the Styrofoam?

b. What is the rate of heat flow per square meter through this wall?



$T_S = 19.0°C$

a) Temp where wood meets styrofoam $T_W = -10.0°C$

$T = T_S - T_W$

$T = 29.0°C$

b) $\frac{dQ}{dt} = KA\frac{T_H - T_C}{L}$

This student set up the correct equations, but didn't make much progress beyond setting them up.

4.

+20 points correct

$m_\ell = 2\,kg$

$V_\ell = 2L = 2\times10^{-3}\,m^3$

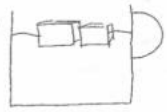
$T_{0,(\ell,Al)} = \cancel{293K}\ 20°C$

$m_{Al} = 0.257\,kg$

$m_{ice} = 0.120\,kg$

$T_{0,ice} = -15°C\ \cancel{258K}$

T_{final}?



$C_w = 4190$

$C_i = 2100$

$C_{Al} = 910$

$L = 3.35\times10^5$

$$Q_{ice,\cancel{cools}\ warms} + Q_{ice,melts} + Q_{ice,water\ warms} + Q_{\ell,cools} + Q_{Al,cools} = 0$$

$$Q_{ice,warms} + Q_{ice,melts} + Q_{ice,water\ warms} = Q_{\ell,cools} + Q_{Al,cools}$$

$$m_i c_i (\underbrace{0°C - -15°C}_{15°C}) + m_i L + m_i c_w (T_f - 0) + m_\ell c_w (T_f - 20) + m_{Al} c_{Al} (T_f - 20) = 0$$

$$15 m_i c_i + m_i L + m_i c_w T_f + m_\ell c_w T_f - 20 m_\ell c_w + m_{Al} c_{Al} T_f - 20 m_{Al} c_{Al} = 0$$

$$T_f (m_i c_w + m_\ell c_w + m_{Al} c_{Al}) = 20 m_\ell c_w + 20 m_{Al} c_{Al} - 15 m_i c_i - m_i L$$

$$T_f = \frac{20 m_\ell c_w + 20 m_{Al} c_{Al} - 15 m_i c_i - m_i L}{m_i c_w + m_\ell c_w + m_{Al} c_{Al}} = \frac{128297.4}{9116.67} \rightarrow \boxed{14.07°C}$$

This student got the correct answer.

+17 points very good

Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

$2000\ mL = 2000\ cm^3$

$V_w = 2 \times 10^{-3}\ m^3$

$m_w = 2\ kg$

$$Q_{ice} + Q_{Al} + Q_w = 0$$

$$Q_{ice} + Q_f + Q_{Al} + Q_w = 0$$

$$m_{ice} c_{ice} \Delta T + m_{ice} L_f + m_{Al} c_{Al} \Delta T + m_w c_w \Delta T + m_{ice} c_w (T_f) = 0$$

$$m_{ice} c_{ice} (15°C) + m_{ice} L_f + m_{Al} c_{Al} (T_f - 20°C) + m_w c_w (T_f - 20°C) + m_{ice} c_w T_f = 0$$

$$m_{Al} c_{Al} T_f - m_{Al} c_{Al} 20°C + m_w c_w T_f - m_w c_w 20°C + m_{ice} c_w T_f = -m_{ice} c_{ice} 15 - m_{ice} L_f$$

$$T_f (m_{Al} c_{Al} + m_w c_w + m_{ice} c_w) = m_{Al} c_{Al} 20°C + m_w c_w 20°C - m_{ice} c_{ice} 15 - m_{ice} L_f$$

$$T_f = \frac{m_{Al} c_{Al} 20°C + m_w c_w 20°C - m_{ice} c_{ice} 15 - m_{ice} L_f}{m_{Al} c_{Al} + m_w c_w + m_{ice} c_w}$$

$$= \frac{(0.257\ kg)(910\ J/kg \cdot K)(293\ K) + (2\ kg)(4190\ J/kg \cdot K)(293\ K) - (0.12\ kg)(2100\ J/kg \cdot K)(15\ K) - (0.12\ kg)(335\ J/kg)}{(0.257\ kg)(910\ J/kg \cdot K) + (2\ kg)(4190\ J/kg \cdot K) + (0.12\ kg)(2100\ J/kg \cdot K)}$$

$$= 272.0164\ K$$

This student forgot a key term, but the rest of the problem-solving was sound.

+15 points good

Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K
Density of water: $\rho = 1.00 \times 10^3$ kg/m³

$20°C = 293.15 K$
$15°C = 288.15 K$

$Q_{mug} + Q_{drink} = Q_{ice}$

$Q_{mug} = m_{mug} c_{mug} \Delta t = m_{mug} c_{alum} (T_i - T_f)$
$= (0.257 kg)(910 \frac{J}{kg \cdot K})(20°C - T_f)$
$Q_{mug} = (233.87 \frac{J}{K})(20°C - T_f)$

$Q_{drink} = (2 kg)(4190 \frac{J}{kg \cdot K})(20°C - T_f)$
$= 8380 \frac{J}{K} (20°C - T_f)$

$Q_{ice} = m_{ice} c_{ice} \Delta T + m_{ice} L_f + m_{ice} c_{water} \Delta T$
$= (0.120 kg)(2100 \frac{J}{kg \cdot K})(0°C - (-15°C)) + (0.12 kg)(3.35 \times 10^5 \frac{J}{kg \cdot K})$
$+ (0.120 kg)(4190 \frac{J}{kg \cdot K})(T_{f\,final} - 0°C)$
$= 112813.8 J + 502.8 \frac{J}{K} (T_f + 273.15 K)$

$(233.87 \frac{J}{K})(293.15 K - T_f) + (8380 \frac{J}{K})(293.15 K - T_f) = 112813.8 J + 502.8 \frac{J}{K} (T_f + 273.15 K)$

rest on scratch

Q4. cont.

$(233.87 \frac{J}{K})(293.15 K - T_f) + (8380 \frac{J}{K})(293.15 K - T_f)$
$= 112813.8 J + 502.8 \frac{J}{K} (T_f + 273.15 K)$

$68556.9905 J - 23.87 \frac{J}{K} (T_f) + 2456594 J - 23.87 \frac{J}{K} (T_f) = 112813.8 J + 502.8 \frac{J}{K} T_f + 137515.8 J$

$-550.54 \frac{J}{K} T_f = -2438428.39 J$

$T_f = 4429.1438 K$

$\Rightarrow$ this answer makes no physical sense
mentally I make an error

This student had all of the necessary terms and right idea solving the problem, but got bogged down in the algebra. However, they correctly assessed that their answer made no physical sense.

+12 points fair

$m_{al} = 0.257\ kg$ $\qquad Q = mL_f$

$m_{ice} = 0.12\ kg$ $\quad T_{ice} = -15°C$ $\qquad = mc\Delta T$

$C_{al} = 910\ J/kg \cdot K$

$C_w = 4190\ J/kg \cdot K$

$C_{ice} = 2100\ J/kg \cdot K$

$L_f = 3.33 \times 10^5\ J/kg \cdot K$

$0.257 \times 910 \times 20 + 0.12 \times 2100 \times (-15) + 2 \times 4190 \times 20$

$= 4677.4 - 3780 + 167600$

$= 168497.4$

$\frac{168497.4}{252 + 253.87 + 8380} = \frac{168497.4}{8865.87} = 19°C$

This student had a good effort, but didn't include all of the necessary terms.

+8 points some attempt

$2.00L \times \frac{10^{-3} m^3}{1L} \times \frac{10^3 kg}{1 m^3} = 2.00\ kg$ $\qquad 20 + 273.15 = 293.15$

$$T = \frac{2.00 \times 293.15 \times 4190 + 0.257 \times 293.15 \times 910 + 0.120 \times 258.15 \times 2100}{2.00 \times 293.15 + 0.257 \times 293.15 + 0.120 \times 258.15}$$

$-15 + 273.15 = 258.15$ $\qquad = 3739.740338\ K$

$Q = -mL_f = 2 \times 3.35 \times 10^5\ J/kg \cdot K = 6.7 \times 10^{+5}\ J/K$

This student attempted at performing the algebra needed to solve the equation

+4 points set up equations

the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?

The specific heat of the aluminum $c_a = 910$ J/kg•K

For liquid water $c_w = 4190$ J/kg•K

For solid ice $c_i = 2100$ J/kg•K

Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K

Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

$1L = 10^{-3}\ m^3$

$2L \cdot \frac{10^{-3}\ m^3}{1L} = 2 \cdot 10^{-3}\ m^3$

$1e3\ \frac{kg}{m^3} \cdot 2e$

$Q = mc\Delta T$

$Q_{water} = (2)(4190)(T_f - 20)$

$Q_{ice} = m_{ice}\ c_{ice}\ \Delta T$

$Q_{ice} = (0.12)(2100)(15)$

$Q_{ice} = (0.120)(3.35e5)$

$Q_{aluminum} = m_{aluminum}\ c_{aluminum}\ \Delta T$

$Q_{aluminum} = (0.257)(910)(T_f - 20)$

$Q = (0.120)(3.35e5) + (0.120)(2100)(15) + (0.257)(910)(T_F - 20) + (2)(4190)(T_F - 20)$

This student set up the equation and applied some conversion factors but didn't make much progress.

5.

+20 points correct

No student got the correct answer.

+17 points very good

Calculate the speed of the fetal heart wall at the instant this measurement is made.

$$f_{\text{heart hears}} = 2\,\text{MHz}\left(\frac{1500+v_{\text{heart}}}{1500}\right) \qquad f_{\text{heart reflects}} = \left(2+\frac{2v_{\text{heart}}}{1500}\right)\left(\frac{1500}{1500-v_{\text{heart}}}\right)$$

$$f_{\text{heart hears}} = \left(2+\frac{2v_{\text{heart}}}{1500}\right)\text{MHz}$$

$$= \frac{3000}{1500-v_{\text{heart}}} + \frac{2v_{\text{heart}}}{1500-v_{\text{heart}}}$$

$$\frac{3000+2v_{\text{heart}}}{1500-v_{\text{heart}}}$$

$$\left|f_{\text{heart hears}} - f_{\text{heart reflects}}\right| = 72$$

$$10^6\left|2+\frac{2v_{\text{heart}}}{1500} - \frac{(3000+2v_{\text{heart}})}{1500-v_{\text{heart}}}\right| = 72\ \text{hz}$$

$$10^6\left|\frac{3000-2v_{\text{heart}}}{1500-v_{\text{heart}}} + \frac{2v_{\text{heart}}}{1500} - \frac{3000-2v_{\text{heart}}}{1500-v_{\text{heart}}}\right| = 72$$

$$10^6\left|\frac{-4v_{\text{heart}}}{1500-v_{\text{heart}}} + \frac{2v_{\text{heart}}}{1500}\right| = 72$$

$$\frac{-4v_{\text{heart}}}{1500-v_{\text{heart}}} + \frac{2v_{\text{heart}}(1-v_{\text{heart}})}{1500-v_{\text{heart}}} = 72\times10^{-6}$$

$$\frac{-2v_{\text{heart}} - 2v_{\text{heart}}^2}{1500-v_{\text{heart}}} = 72\times10^{-6}$$

$$2v^2 + 2v_{\text{heart}} + 6.192 = 0$$

$$-2 \pm \frac{\sqrt{4-0.768}}{4} = -2 \pm 0.505\ \frac{m}{s}$$

Had both Doppler effect and attempted to solve them.

+15 points good

$$f_{L_1} = \frac{v+v_L}{v+v_s}f_s = \frac{1500+v_L}{1500+v_s}2\times10^6$$

reflected sound: $f_{L_2} = \frac{1500+v_L}{1500-v_s}2\times10^6$

$$f_{\text{beat}} = f_1 - f_2 = 72\ \frac{\text{beat}}{s}\ (\text{Hz})$$

$$72 = 2\times10^6\left(\frac{1500+v_L}{1500+v_s} - \frac{1500+v_L}{1500-v_s}\right)$$

$$36\times10^{-6} = \frac{1500^2 - 1500v_s + 1500v_L - v_sv_L + 1500^2 - 1500v_L - 1500v_s - v_sv}{1500^2 - v_s^2}$$

$$36\times10^{-6} = \frac{-3000v_s - 2v_sv_L}{1500^2 - v_s^2}$$

This student had both Doppler effects, couldn't fully solve them.

+12 points fair

$v = 1500\,m/s \quad f_a = 2\times10^6\,Hz \quad f_{sent} = 72\,Hz$

$f_{sent} = |f_a - f_b|$ $\quad f_b$ is the frequency received

Since heart wall moves toward receiver, $f_b > f_a$

$\therefore f_b = 2\times10^6\,Hz + 72\,Hz = 2{,}000{,}072\,Hz$

Now can use Doppler Effect

receiver is stationary while the source (heart wall) moves toward the receiver

$$f_b = \frac{v}{v + v_s} f_a$$

$$v_s = v \cdot \frac{f_a}{f_b} - v$$

$$= v\left(\frac{f_a}{f_b} - 1\right) = 1500\,m/s\left(\frac{2\times10^6\,Hz}{2{,}000{,}072\,Hz} - 1\right)$$

$$= 0.054\,m/s$$

This student only set up one Doppler effect rather than two.

+8 points some attempt

Calculate the speed of the fetal heart wall at the instant this measurement is made.

This question refers to the Doppler effect:

$B = 72 \frac{\text{beats}}{\text{sec}}$

$V_b = 1500 \frac{m}{s}$

$V_L = ?$

Assuming $V_S = 1500 \frac{m}{s}$

$f_{beat} = f_a - f_b = f_{higher} - f_{lower} = 72 \frac{\text{beats}}{\text{sec}}$

Therefore L is at rest and source is moving : left to right : +x

$\therefore f_L = \frac{v}{v+v_s} f_s$ where $f_s = 2{,}0 \times 10^6 \, Hz$

$V_s = 1500 \, m/s$ (assuming)

$= \frac{299792458 \frac{m}{s}}{299792458 \frac{m}{s} + 1500 \frac{m}{s}} \cdot 2{,}0 \times 10^6 \, Hz$

$f_L = 1999989{,}9 \, Hz$

where: $\lambda_L = \frac{v_L}{f_L}$ and $\lambda_L = 0{,}5 \, m$ (assume)

$v_L = \lambda_L \cdot f_L = 1 \times 10^6 \frac{m}{s}$ (which is unrealistic)

Applied one Doppler equation, didn't use it correctly.

+4 points set up equations

$f_{rL} = ?$ $2MHz = f_s$ $V_W = 1500 \frac{m}{s}$

L •))) (((• $V_s = 0 \frac{m}{s}$

1 $\xleftarrow{(+)}$

$f_{beat} = |f_s - f_{rL}|$ $f_L = \left(\frac{V_W + V_L}{V_W \cancel{+ V_S}}\right)(f_s)$

$f_{beat} = \frac{72}{s}$

2 $\xrightarrow{(+)}$

$f_{rL} = \left(\frac{V_W \cancel{+ V_S}}{V_W + V_L}\right)(f_L)$

$f_L = \frac{f_{rL}(V_W + V_L)}{V_W}$

This student set up the Doppler equations, but didn't make much progress afterward.

HSIEH_JENNIFER

From: FARIDIAN_FOROUZAN
Sent: Sunday, March 16, 2025 8:06 PM
To: HSIEH_JENNIFER; MENACHEKANIAN_EMIN; ROBERTS_KEVIN31
Subject: Exam 2 kevin FF key with 5 graded exams ff
Attachments: Exam 2 kevin FF key with 5 graded exams ff.pdf

Hello everyone,

I looked at Kevin's old midterm and made a key and graded the given exams for comparison. Here is a pdf of the rubric, key, and the graded exams.

Forouzan

Sent from my iPad

I have made a rubric and key for Kevin's old midterm and graded the exams sent.

Rubric: In each problem, points will be given for:
- Stating the givens, including necessary diagrams
- An expression (written out or mathematical) of concept
-Correct understanding of what the formula stands for
- Correct substitution of values for variables
- Correct answer and units.
- If final answer is correct with a logical thought process, full credit is given.

Below is a detailed list of concepts, followed by a key to the exam and graded work of five students.

Forouzan

Q1 concepts:

$PV = nRT$

$N = nN_A$

P in Pa
T in K
V in m^3

All in SI units

Finding n using volume of sphere $V = \frac{4}{3}\pi R^3$, density & molar mass, then finding P.

Q2 concepts: a fundamental frequency for a wire:

$v = f\lambda$ $\Rightarrow f = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$

$v = \sqrt{\frac{F}{\mu}}$

$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L} \Rightarrow \Delta L = \frac{FL}{AY}$

$L = L_0 + \alpha L_0 \Delta T \Rightarrow \Delta L = \alpha L_0 \Delta T$

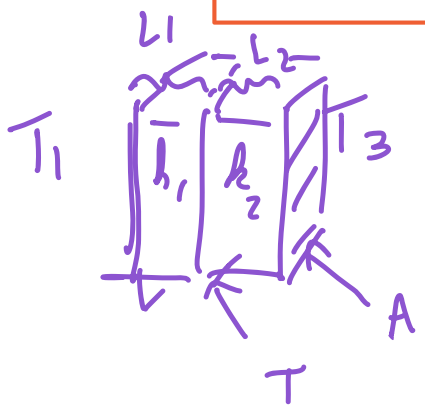
relate Δf to ΔT.

v in m/s
f in Hz
L in m
μ in kg/m
F in N

$L = \frac{\lambda}{2} \Rightarrow \lambda = 2L$

SI units

Q 3 concepts:



a) $H = \dfrac{-k A \Delta T}{L}$ all in SI units

$H_1 = H_2$

b) $H_{total} = \dfrac{T_3 - T_1}{R_1 + R_2}$ where $R = \dfrac{L}{kA}$

$$= \frac{T_3 - T_1}{\frac{L_1}{k_1 A} + \frac{L_2}{k_2 A}} = \frac{(T_3 - T_1)\, k_1 k_2 A}{(L_1 k_2 + L_2 k_1)}$$

looking for T_1 & H_{total}/A

Q4 concepts: Calorimetry. SI units

$Q_{lost} = Q_{gained}$

$Q_{Al} + Q_{water} = Q_{ice\ warming} + Q_{ice\ melting} + Q_{ice\ water\ warming}$.

$Q = mc\Delta T$; $Q = mL_f$

Q5 concepts: - Doppler effect. $f' = f \dfrac{v \pm v_o}{v \pm v_s}$ All SI units

twice ... $\Rightarrow f'' = f \dfrac{v + v_{heart}}{v - v_{heart}}$

- Beat : $\Delta f = f'' - f$

Find v_s

Grade distribution follows.

Results:

Based on the above; here are the student grades:

K[redacted] 21% F
S[redacted] 39% F
J[redacted] 15% F
T[redacted] 73% C
Ta[redacted] 23.5% F

If I were to curve, following Kevin's grade of 92%for Tyler :

curved grades: compared to(Kevin's grades).

T[redacted] 92% (vs 92 %)
K[redacted] 26.4% (vs. 43%)
S[redacted] 49% (vs. 66%)
J[redacted] 19 % (vs. 28 %)
Ta[redacted] 29.6 % (vs. 80 %)

Forouzan

Exam 2
Physics 23
Fall 2024

Chapters 16 – 18

Name:

key FF

Your test has 5 problems, each worth 20 points.

Some useful constants:
Acceleration due to gravity: $g = 9.80\ m/s^2$
$1\ atm = 1.013 \times 10^5\ Pa$
Gas constant: $R = 8.314\ J/mol{\bullet}K$
$N_A = 6.022 \times 10^{23}\ particle/mole$

1. Modern vacuum pumps make it easy to attain pressures of the order of 10^{-13} atm in the laboratory. Consider a volume of air and treat the air as an ideal gas.

   1/5 a. At a pressure of 9.00×10^{-14} atm and an ordinary temperature of 300.0 K, how many molecules are present in a volume of 1.00 cm^3?

   1/5 b. How many molecules would be present at the same temperature but at 1.00 atm instead?

   1/20 c. Let compare this lab to astrophysical example, the Lagoon Nebula. The Lagoon Nebula is a cloud of hydrogen gas (molar mass of 2.016 g/mol) located 3900 light-years from the earth. The cloud is about 45 light-years in diameter and glows because of its high temperature of 7500 K. (The gas is raised to this temperature by the stars that lie within the nebula.) The cloud is also very thin; there are only 80 molecules per cubic centimeter. Find the gas pressure (in atmospheres) in the Lagoon Nebula. Compare it to the laboratory pressure in part (a). 1/6 1/2

   d. Science-fiction films sometimes show starships being buffeted by turbulence as they fly through gas clouds such as the Lagoon Nebula. Does this seem realistic? Why or why not? 1/2

Use 1 atm = 1.013×10^5 Pa, 1 $cm^3 = 1.00 \times 10^{-6}\ m^3$,
$N_A = 6.022 \times 10^{23} particle/mole$

Given:

a) $P_1 = 9.00 \times 10^{-14}\ atm \times \frac{1.013 \times 10^5\ Pa}{1\ atm} = 9.117 \times 10^{-9}\ Pa$ 1/2

$T_1 = 300\ K$

$V_1 = 1.00\ cm^3 \times \frac{(1\ m)^3}{(10^2\ cm)^3} = 10^{-6}\ m^3$ 1/2

1/20

want: $N = ?$ 1

Use: $PV = nRT$ 1

$n = \frac{PV}{RT} = \frac{(9.117 \times 10^{-9}\ Pa)(10^{-6}\ m^3)}{(8.314\ J/mol\,K)(300\ K)} = 3.66 \times 10^{-18}$ moles 1

5/5

$N = n N_A = 3.66 \times 10^{-18} \times 6.022 \times 10^{23} = \boxed{2.2 \times 10^{6}\ \text{molecules}}$ 1

b) $T_2 = 300\ K$

1 $P_2 = 1\ atm \times \frac{1.013 \times 10^5\ Pa}{1\ atm} = 1.013 \times 10^5\ Pa$

$V_2 = 10^{-6}\ m^3$

5/5

$PV = nRT$ (1)

$n = \frac{PV}{RT} = \frac{(1.013 \times 10^5)(10^{-6})}{(8.314)(300)} = 4.06 \times 10^{-5}$ moles (1)

(1) $N = nN_A = 4.06 \times 10^{-5}$ moles $\times \frac{6.02 \times 10^{23} \text{ molecules}}{\text{mole}} = 24.4 \times 10^{18}$ molecules

(1) $\boxed{N = 24.4 \times 10^{18} \text{ molecules}}$

---

c) (1) $M = \frac{2.016 \text{ g}}{\text{mol}}$

LY = distance light travels in 1 yr

$T = 7500$ K

(1) $D = 45 \text{ LY} = 45 \times \frac{3 \times 10^8 \text{ m}}{\text{s}} \times \frac{3600 \text{ s}}{1 \text{ hr}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{365 \text{ days}}{\text{yr}} = 4.25 \times 10^9 \text{ m}$

Assuming spherical shape $\Rightarrow V = \frac{4}{3}\pi\left(\frac{D}{2}\right)^3$ (1)

$V = \frac{4}{3}\pi\left(\frac{4.25 \times 10^9}{2}\right)^3 = 40.2 \times 10^{27} \text{ m}^3$

6/6

$\rho = \frac{80 \text{ molecules}}{\text{cm}^3} \Rightarrow$ # of molecules $= \frac{80 \text{ molecules}}{\text{cm}^3} \times \frac{40.2 \times 10^{27} \text{ m}^3}{} \times \frac{10^6 \text{ cm}^3}{1 \text{ m}^3}$

$\Rightarrow N = 3.216 \times 10^{33}$ molecules $\Rightarrow n = \frac{N}{N_A} = \frac{3.216 \times 10^{33}}{6.022 \times 10^{23}} = 534 \times 10^{10}$ moles (1)

$P = ?$

(1) $PV = nRT \Rightarrow P = \frac{nRT}{V}$

$$P = \frac{(534 \times 10^{10}\ \text{mol})(8.314\ \text{J/mol K})(7500\ \text{K})}{40.2 \times 10^{27}\ \text{m}^3}$$ (1)

$$= 8.29 \times 10^{5+10-27} = \boxed{8.29 \times 10^{-12}\ \text{Pa}}$$

- compared to the lab vacuum of part a!

2/2 9.117×10^{-9} Pa (1)

$$\Rightarrow \frac{8.29 \times 10^{-12}\ \text{Pa}}{9.117 \times 10^{-9}\ \text{Pa}} = \boxed{0.91 \times 10^{-3}}$$ → almost a thousandth of it! (1)

d) $\boxed{\text{No}}$, as there are very few molecules to cause any disturbance.

(2)

$m = 0.0025\ kg$, $L = 0.4\ m$ $\Rightarrow$ $\rho = \frac{M}{V} = \frac{M}{AL} = \frac{0.0025}{0.4A} = 7800\ kg/m^3$

$\Rightarrow 0.4A = \frac{0.0025}{7800} \Rightarrow A = \frac{0.0025}{(0.4)(7800)} = A = 8\times10^{-7}\ m^2$ (1)

2. A steel wire has density 7800 kg/m^3 and mass 2.50 g. It is stretched between two rigid supports separated by 0.400 m.
   a. When the temperature of the wire is 20.0°C, the frequency of the fundamental standing wave for the wire is 440 Hz. What is the tension in the wire? 10
   b. What is the temperature of the wire if its fundamental standing wave has frequency 460 Hz? 10

   For steel the coefficient of linear expansion is $\alpha = 1.2 \times 10^{-5}\ K^{-1}$ and Young's modulus is $Y = 20 \times 10^{10}$ Pa.
   Hint 1: if the steel wire is already under tension, would the temperature need to increase or decrease for the fundamental frequency to increase?
   Hint 2: The "F" in thermal stress equation is not the tension directly.
   This is why your favorite band needs to tune their instruments in every new venue.

/20

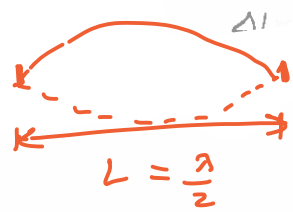
Given

(1) $\rho = 7800\ kg/m^3$

$m = 2.5\ g \times \frac{1\ kg}{10^3\ g} = 0.0025\ kg$

$\mu = \frac{m}{L} = \frac{0.0025}{0.4} = 0.00625\ kg/m$ (1) fundamental mode!

$L = 0.400\ m$



a) $f_1 = 440\ Hz$

$T_1 = 20 + 273 = 293\ K$ (1)

$\vec{F} = ?$

10/10

(1) $L = \frac{\lambda}{2} \Rightarrow \lambda = 2L = 2(0.400) = 0.8$ (1)

$\mu = \frac{M}{V} = \frac{M}{A} = \rho A$

(1) $v = f\lambda = (440\ Hz)(0.8\ m) = 352\ m/s$ (1)

(1) $v = \sqrt{\frac{F}{\mu}} \Rightarrow v^2 = \frac{F}{\mu} \Rightarrow F = \rho v^2 A$ (1)

$F = (7800\ kg/m^3)(352\ m/s)^2(8\times10^{-7}\ m^2) = \boxed{773\ N}$ (1)

b) $Y = \frac{\text{Thermal stress}}{\text{strain}} = \frac{F/A}{\frac{\Delta L}{L}}$ (1)

$L = L_0(1 + \alpha\Delta T) \Rightarrow \Delta L = L - L_0 = \alpha \Delta T L_0$ (1)

$\frac{\Delta L\, Y}{L_0} = \frac{F}{A} \Rightarrow \Delta L = \frac{F L_0}{AY}$ (1)

Thermal stress.

$\Rightarrow \alpha \Delta T L_0 = \frac{F L_0}{AY} \Rightarrow \frac{F}{AY} = \alpha \Delta T \Rightarrow \Delta T = \frac{F}{AY\alpha}$ (1)

$$v = f\lambda = \sqrt{\frac{F}{\mu}} \Rightarrow f = \frac{v}{\lambda} = \frac{1}{2L}\sqrt{\frac{F}{\mu}} \quad (1)$$

10/10

$$L = \frac{\lambda}{2} \Rightarrow \lambda = 2L \Rightarrow \frac{f_2}{f_1} = \frac{\frac{1}{2L}\sqrt{\frac{F_2}{\mu}}}{\frac{1}{2L}\sqrt{\frac{F_1}{\mu}}} = \sqrt{\frac{F_2}{F_1}} \quad (1)$$

$$\frac{460}{440} = \sqrt{\frac{F_2}{773}} \Rightarrow F_2 = 773 \times \left(\frac{460}{440}\right)^2 = 845\,N \quad (1)$$

This is the actual stress, combination of applied forces & stress due to temperature.

F_2 = Applied Force + thermal stress$_2$ = 845

F_1 = Applied force + thermal stress$_1$ = 773 (1)

$\Rightarrow F_2 - F_1 = \Delta$ thermal stress = 72 N

$$\Delta T = \frac{\Delta F}{AY\alpha} = \frac{72}{(8\times10^{-7})(20\times10^{10})(1.2\times10^{-5})} = 37.5^\circ \quad (1)$$

Since $f_2 > f_1 \Rightarrow v_2 > v_1 \Rightarrow F_2 > F_1 \Rightarrow$ more tension, string is shorter, Temperature lower $\Rightarrow T_2 = 20 - 37.5 = \boxed{-17.5^\circ}$ (1)

b) $\boxed{\text{method 2}}$

$$Y = \frac{F/A}{\Delta L/L} \Rightarrow F = \frac{AY\Delta L}{L} = \frac{AY}{L}\Delta L$$ 1

recall $F = -k\Delta x$ from Hooke's law,

so when there is a stretch, there is a change in the force : $k = \frac{AY}{L}$ 1

$$\Delta F = -\frac{AY}{L}\Delta L = -\frac{AY}{L}(\alpha \Delta T L) = -AY\alpha\Delta T$$ 1

$$f_2 = 460 \text{ Hz} \Rightarrow v = f\lambda = f_2 2L$$

$$\Rightarrow f_2 = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{F_2}{\mu}}$$ 1

$$\Rightarrow \mu(2Lf_2)^2 = F_2 = 4L^2 f_2^2 \mu$$ 1

The frequency has increased, so the speed has increased, so the tension has increased because the length has decreased by ΔL. 1

$$\Delta F = F_2 - F_1 = 4L^2 f_2^2 \mu - 4L^2 f_1^2 \mu$$ 1

$$= 4L^2 \mu (f_2^2 - f_1^2) = 4(0.4)^2 (0.00625)(460^2 - 440^2)$$

$$= (211{,}600 - 193{,}600)(0.004)$$

$$= 72$$ 1 (force due to thermal expansion)

$$\Delta F = -AY\alpha \Delta T \Rightarrow \Delta T = -\frac{\Delta F}{AY\alpha}$$

$$\Delta T = \frac{72}{(8\times10^{-7})(20\times10^{10})(1.2\times10^{-5})} = -\frac{0.375\times10^{7-10+5}}{} = -37.5$$ 1

1

$$T_f = T_i - 37.5 = 20 - 37.5^\circ = \boxed{-17.5^\circ C}$$

in out

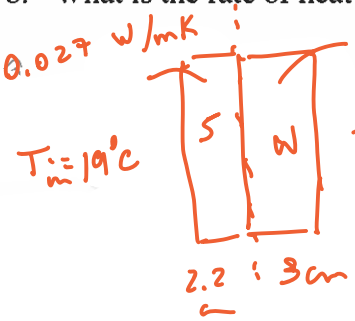
3. A carpenter builds an exterior house wall with a layer of wood 3.0 cm thick on the outside and a layer of Styrofoam insulation 2.2 cm thick on the inside wall surface. The wood has k = 0.080 W/m•K, and the Styrofoam has k = 0.027 W/m•K. The interior surface temperature is 19.0°C, and the exterior surface temperature is –10.0°C.

10/10 a. What is the temperature at the plane where the wood meets the Styrofoam?

10/10 b. What is the rate of heat flow per square meter through this wall?

a) $k = 0.027$ W/mK

$k_{wood} = 0.080$ W/mK



1

Given: $T_{in} = 19 + 273 = 292$ K 1

$T_{out} = -10 + 273 = 263$ K 1

10/10

Rate of heat flow $= H = \dfrac{-kA\,\Delta T}{L}$ 1

wood $H = \dfrac{-(0.08)(A)(T-263)}{3\times10^{-2}}$ 1

$H = \dfrac{-(0.027)(A(292-T)}{2.2\times10^{-2}}$ 1

$\dfrac{0.08\,A\,(263-T)}{3\times10^{-2}} = \dfrac{0.027\,A\,(T-292)}{2.2\times10^{-2}}$ 1 1

$0.08(263-T)(2.2) = (0.027)3(T-292)$

$46.288 - 0.176T = 0.081T - 23.652$

$69.94 = 0.257T$

1 $T = \dfrac{69.94}{0.257} = \boxed{272\ K}$ 1

b) $R = \frac{\Delta x}{kA}$ (1) $\qquad H = \frac{T_1 - T_3}{R_1 + R_2}$ (1)

$$R_1 = R_{wood} = \frac{0.03}{(0.080)A} = \frac{3}{8A}$$ (1) (1)

10/10

$$R_2 = R_{sky} = \frac{0.022}{(0.027)A} = \frac{22}{27A}$$ (1) (1)

(1) $$\frac{H}{A} = \frac{19 - (-10)}{\frac{3}{8}A + \frac{22}{27}A} = \frac{29}{\frac{3}{8} + \frac{22}{27}} = 24.37\ W/m^2$$ (1)

$$\simeq \boxed{24.4\ W/m^2}$$

(1) (1)

4. A thirsty nurse cools a 2.00 L bottle of a soft drink (mostly water) by pouring it into a large aluminum mug of mass 0.257 kg and adding 0.120 kg of ice initially at –15.0°C. If the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?

The specific heat of the aluminum $c_a = 910$ J/kg•K
For liquid water $c_w = 4190$ J/kg•K
For solid ice $c_i = 2100$ J/kg•K
Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K
Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

20

$\rho = 1\times10^3 \text{ kg/m}^3 = \frac{M}{V}$

$\Rightarrow M_w = \rho V = 10^3 \times 2\times10^{-3} = 2 \text{ kg}$

$V = 2.00 \text{ l} \times \frac{1 \text{ dm}^3}{1 \text{ l}} \times \frac{(1 \text{ m})^3}{(10 \text{ dm})^3} = 2\times10^{-3} \text{ m}^3$ (1)

1

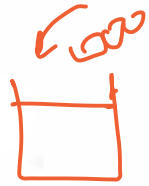
$T_i = 20°C + 273 = 293 K$ (1)

$m_{Al} = 0.257$ kg

$c_{Al} = 910$ J/kg K

$m_{ice} = 0.120$ kg

$T_{i\,ice} = -15 + 273 = 258$ K



(1)

Heat lost = heat gained

$m_{Al} c_{Al} (\Delta T_{Al}) + m_w c_w \Delta T_w = m_{ice} c_{ice} \Delta T_{ice} + m_{ice} L_f + m_{iw} c_w \Delta T_{iw}$

(1) (1) (1) (1) (1) (1)

$(0.257 \text{ kg})(910 \text{ J/kg K})(293 - T_f) + (2 \text{ kg})(4190 \text{ J/kg K})(293 - T_f)$

(1) (1) (1) (1) (1) (1)

$= (0.120 \text{ kg})(2100 \text{ J/kg K})(273 - 258) + (0.120 \text{ kg})(3.35\times10^5 \text{ J/kg K})$

$+ (0.120 \text{ kg})(4190 \text{ J/kg K})(T_f - 273)$

(1) (1) (1)

20/20

$234(293 - T_f) + 8380(293 - T_f) =$

$3780 + 40{,}200 + 502.8(T_f - 273)$

$(234)(293) - 234T_f + (8380)(293) - 8380T_f =$

$3780 + 40{,}200 + 502.8T_f - (502.8)(273)$

$68{,}562 + 2{,}455{,}340 - 8614T_f =$

$43{,}980 - 137{,}264.4 + 502.8T_f$

$2{,}617{,}186.4 = (502.8 + 8614)T_f$

$T_f = 287$ K

$T_f = 287 - 273 = \boxed{14.1°C}$ (1)

3200 Hz

5. A 2.00 MHz sound wave travels through a pregnant woman's abdomen and is reflected from the fetal heart wall of her unborn baby. The heart wall is moving toward the sound receiver as the heart beats. The reflected sound is then mixed with the transmitted sound, and 72 beats per second are detected. The speed of sound in body tissue is 1500 m/s. Calculate the speed of the fetal heart wall at the instant this measurement is made.

/20

(1) $f = 2.00 \times 10^6$ Hz ; $v = 1500$ m/s ; $v_0 = ?$

(0) → (s)

$$f' = f\left(\frac{v + v_0}{v}\right) \quad (3)$$

source

(s) ← (1)

$$f'' = f'\left(\frac{v}{v - v_s}\right) \quad (3)$$

$$\Rightarrow f'' = f\left(\frac{v + v_0}{v}\right)\left(\frac{v}{v - v_s}\right) = f\left(\frac{v + v_0}{v - v_0}\right) \quad (2)$$

$$f'' - f = 72 \quad (3)$$

20/20

$$\Rightarrow f'' = f + 72 = 2{,}000{,}000 + 72 = 2{,}000{,}072 \text{ Hz}$$

$$2{,}000{,}072 = 2{,}000{,}000\left(\frac{1500 + v_0}{1500 - v_0}\right) \quad (1)$$

(1) (1) (1) (1)

$$(2{,}000{,}072)(1500 - v_0) = 2{,}000{,}000(1500 + v_0)$$

$$1500(2{,}000{,}072 - 2{,}000{,}000) = 4{,}000{,}072\, v_0$$

$$v_0 = \frac{1500(72)}{4{,}000{,}072} = 0.027 \text{ m/s} = \boxed{2.7 \text{ cm/s}}$$

(1) (1)

Based on the above, here are the student grades:

Kevin	21%	F
Samuel	39%	F
Jun-Kevin	15%	F
Tyler	73%	C
Taber	23.5%	F

If I were to curve, following Kevin's grade of 92% for Tyler →

curved grades: compared to Kevin's grades.

Tyler	92%	A	→	92	A
Kevin	26.4%	F	→	43	F
Samuel	49%	F	→	66	D
Jun-Kevin	19%	F	→	28	F
Taber.	29.6%	F	→	80	B

Exam 2
Physics 23
Fall 2024

Chapters 16 – 18

Name:

K[redacted] 21/100

Your test has 5 problems, each worth 20 points.

Some useful constants:
Acceleration due to gravity: g = 9.80 m/s^2
1 atm = 1.013×10^5 Pa
Gas constant: R = 8.314 J/mol•K
$N_A = 6.022 \times 10^{23}\ particle/mole$

21/100

1. Modern vacuum pumps make it easy to attain pressures of the order of 10^{-13} atm in the laboratory. Consider a volume of air and treat the air as an ideal gas.
   a. At a pressure of 9.00×10^{-14} atm and an ordinary temperature of 300.0 K, how many molecules are present in a volume of 1.00 cm^3?
   b. How many molecules would be present at the same temperature but at 1.00 atm instead?
   c. Let compare this lab to astrophysical example, the Lagoon Nebula. The Lagoon Nebula is a cloud of hydrogen gas (molar mass of 2.016 g/mol) located 3900 light-years from the earth. The cloud is about 45 light-years in diameter and glows because of its high temperature of 7500 K. (The gas is raised to this temperature by the stars that lie within the nebula.) The cloud is also very thin; there are only 80 molecules per cubic centimeter. Find the gas pressure (in atmospheres) in the Lagoon Nebula. Compare it to the laboratory pressure in part (a).
   d. Science-fiction films sometimes show starships being buffeted by turbulence as they fly through gas clouds such as the Lagoon Nebula. Does this seem realistic? Why or why not?

6.5/20

Use 1 atm = 1.013×10^5 Pa, 1 $cm^3 = 1.00 \times 10^{-6}\ m^3$,
$N_A = 6.022 \times 10^{23} particle/mole$

Not SI units → convert. (-1)

(1) PV=nRT

a. 9.00×10^{-14} atm $\times 1.00 cm^3 = n \times 8.314\ J/mol \cdot K \times 300.0K$

3/5

$n = 3.6 \times 10^{-17}$ moles (-1) Not SI units

$3.6 \times 10^{-17} \times \frac{6.022 \times 10^{23}}{1 mol} = 2.17 \times 10^{7}$ molecules. (-1)

b. $1 \times 1 = n \times 8.314 \times 300k$, $n = 4.00 \times 10^{-4}$ mols

(1)

3/5

4.00×10^{-4} mols $\times \frac{6.022 \times 10^{23}}{1 mol}$ (1) $= 20.088 \times 10^{19}$ molecules.

c. Hydrogen gas $\frac{1 mol}{2.016 g} \times 1.01 g = 0.5$ mol.

?

0.5/8

$R = \frac{PV}{nT}$

d. Yes

0/2

2. A steel wire has density 7800 kg/m^3 and mass 2.50 g. It is stretched between two rigid supports separated by 0.400 m.
   a. When the temperature of the wire is 20.0°C, the frequency of the fundamental standing wave for the wire is 440 Hz. What is the tension in the wire?
   b. What is the temperature of the wire if its fundamental standing wave has frequency 460 Hz?
   For steel the coefficient of linear expansion is $\alpha = 1.2 \times 10^{-5}\ K^{-1}$ and Young's modulus is $Y = 20 \times 10^{10}$ Pa.
   Hint 1: if the steel wire is already under tension, would the temperature need to increase or decrease for the fundamental frequency to increase?
   Hint 2: The "F" in thermal stress equation is not the tension directly.
   This is why your favorite band needs to tune their instruments in every new venue.

2/20

1

1 $\Delta L = L_0 \alpha \Delta T$ $\alpha = 1.2 \times 10^{-5} K^{-1}$, $Y = 20 \times 10^{10}$ Pa.

$\sigma = E \alpha \Delta T = 1.2 \times 10^{-5} K^{-1} \times 20 \times 10^{10}$ Pa $\times \Delta T$.

α Y

what is this?

$= 1.2 \cancel{\times 10^{-5} K^{-1}} \times 20 \times 10^{10}$ Pa $\times \frac{\Delta L}{L_0 \cancel{\alpha}}$ $= 20 \times 10^{10}$ Pa $\times \frac{\Delta L}{L_0}$

in out

3. A carpenter builds an exterior house wall with a layer of wood 3.0 cm thick on the outside and a layer of Styrofoam insulation 2.2 cm thick on the inside wall surface. The wood has k = 0.080 W/m•K, and the Styrofoam has k = 0.027 W/m•K. The interior surface temperature is 19.0°C, and the exterior surface temperature is –10.0°C.
   a. What is the temperature at the plane where the wood meets the Styrofoam?
   b. What is the rate of heat flow per square meter through this wall?

2.5/20

$$Q = \frac{k A \Delta T}{d}$$ 1

$$T_{bound} = T_{out} - T_{in} = \frac{Q d_{out}}{k_{out} A} - \frac{Q d_{in}}{k_{in} A} = \frac{Q \times 3}{0.08 \times A} - \frac{Q \times 2.2}{0.027 A}$$

2.5/10

1

$$Q_{out} = \frac{0.080 W/mok \times A \times (-10)}{3}$$ T-

1/2 ← convert to meters.

a) 6°C

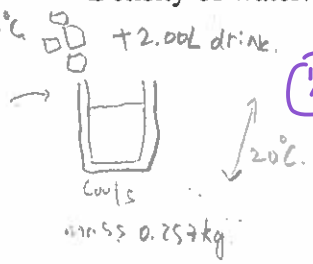
b) $Q = \frac{k \times A \times 6}{5.2}$

0/10

9/20

4. A thirsty nurse cools a 2.00 L bottle of a soft drink (mostly water) by pouring it into a large aluminum mug of mass 0.257 kg and adding 0.120 kg of ice initially at –15.0°C. If the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?
The specific heat of the aluminum $c_a = 910$ J/kg•K
For liquid water $c_w = 4190$ J/kg•K
For solid ice $c_i = 2100$ J/kg•K
Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K
Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

0.120kg.
-15.0°C +2.00L drink.



1/2

$Q = mc\Delta T$

ice -15°C→0, 0.120kg × 2100J/kg•K × 15°C = Q_1 = 3780 (1) (1) (1)

cool. 20°C→ drink (1.00×10³kg/m³ × 2.00L) × 4190J/kg•K × (20−x) × 1/(3.35×10⁵kg•K) = Q_2 (1/2) (1) (1) (1)
T x

mug: (0.257kg) × 910/kg•K (20−x) = Q_3 (1) (1) (1)

$Q_1 + Q_2 + Q_3 = 0$

(25 + 234) (20 − x) + 3780 = 0

Q_4 = ice water → T

$20 - x = \frac{-3780}{259} = 14.6$

$x = 5.4$

3200 Hz

5. A 2.00 MHz sound wave travels through a pregnant woman's abdomen and is reflected from the fetal heart wall of her unborn baby. The heart wall is moving toward the sound receiver as the heart beats. The reflected sound is then mixed with the transmitted sound, and 72 beats per second are detected. The speed of sound in body tissue is 1500 m/s. Calculate the speed of the fetal heart wall at the instant this measurement is made.

1/20

2.00 MHz (1)

72 beats/s

1500 m/s

fetal heart wall.

2000 Hz x

$\frac{1500}{72}$

$\frac{1500}{72} \times 2000 = 41666.6$

Exam 2
Physics 23
Fall 2024

Chapters 16 – 18

Name:

S[redacted]

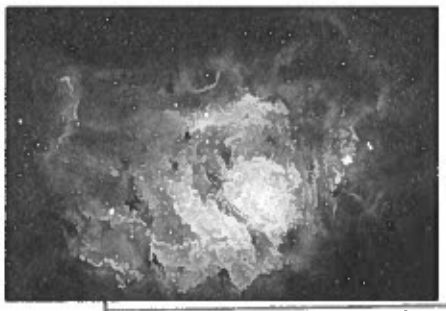
Your test has 5 problems, each worth 20 points.

Some useful constants:
Acceleration due to gravity: g = 9.80 m/s^2
1 atm = 1.013×10^5 Pa
Gas constant: R = 8.314 J/mol•K
$N_A = 6.022 \times 10^{23}\ particle/mole$

39/100

1. Modern vacuum pumps make it easy to attain pressures of the order of 10^{-13} atm in the laboratory. Consider a volume of air and treat the air as an ideal gas.
   a. At a pressure of 9.00×10^{-14} atm and an ordinary temperature of 300.0 K, how many molecules are present in a volume of 1.00 cm^3?
   b. How many molecules would be present at the same temperature but at 1.00 atm instead?
   c. Let compare this lab to astrophysical example, the Lagoon Nebula. The Lagoon Nebula is a cloud of hydrogen gas (molar mass of 2.016 g/mol) located 3900 light-years from the earth. The cloud is about 45 light-years in diameter and glows because of its high temperature of 7500 K. (The gas is raised to this temperature by the stars that lie within the nebula.) The cloud is also very thin; there are only 80 molecules per cubic centimeter. Find the gas pressure (in atmospheres) in the Lagoon Nebula. Compare it to the laboratory pressure in part (a).
   d. Science-fiction films sometimes show starships being buffeted by turbulence as they fly through gas clouds such as the Lagoon Nebula. Does this seem realistic? Why or why not?

8/20



Use 1 atm = 1.013×10^5 Pa, 1 $cm^3 = 1.00 \times 10^{-6}\ m^3$, $N_A = 6.022 \times 10^{23} particle/mole$

a) $PV = nRT$

3/5

$n = \frac{PV}{RT}$ (1)

$n = \frac{(9.12 \times 10^{-9}\ Pa)(1 \times 10^{-6}\ m^3)}{(8.314\ \frac{J}{mol \cdot K})(300\ K)}$

$n = 3.66 \times 10^{-18}$ mol (1)

2. N = ? # of molecules? (-2)

Known: For A, B.

$P = 9.00 \times 10^{-14}$ atm $= 9.12 \times 10^{-9}$ Pa (1/2)

$V = 1.00\ cm^3 \cdot \left(\frac{1m}{10^2 cm}\right)^3 = 1 \times 10^{-6}\ m^3$ (1/2)

$R = 8.314\ \frac{J}{mol \cdot K}$

$T = 300\ K$

b) $n = \frac{(1.013 \times 10^5\ Pa)(1 \times 10^{-6}\ m^3)}{(8.314\ \frac{J}{mol \cdot K})(300\ K)}$ (1/2) (1/2)

$n = 4.06 \times 10^{-5}$ mol

3/5 = # of molecules? (-2)

Known: LD, C) (+1/2)

$M = 2.016\ \frac{g}{mol} \cdot \frac{1 kg}{1000 g} = 2.016 \times 10^{-3}\ \frac{kg}{mol}$

$T = 7500\ K$

$N = 80\ \frac{molecules}{cm^3} \cdot \left(\frac{10^2 cm}{1 m}\right)^3 = 8 \times 10^7\ \frac{mol}{m^3}$ (+1/2)

molecules, not moles.

$P = \frac{nRT}{V}$ (1)

$P = NMRT$

2/6

careful!

$P = (8 \times 10^7\ \frac{molecules}{m^3})(2.016 \times 10^{-3}\ \frac{kg}{mol})(8.314\ \frac{J}{mol \cdot K})(7500\ K)$

V = ?

$P = 1.01 \times 10^{10}$ Pa

$P = 9.93 \times 10^4$ atm

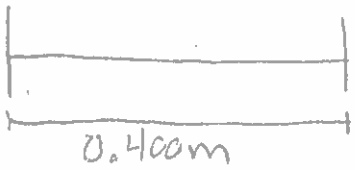
This is a dramatically higher pressure than the pressure in a)

D) This is slightly realistic due to a higher pressure, and more molecules running around... Also faster more sporadic movement.

0/2

2. A steel wire has density 7800 kg/m^3 and mass 2.50 g. It is stretched between two rigid supports separated by 0.400 m.
   a. When the temperature of the wire is 20.0°C, the frequency of the fundamental standing wave for the wire is 440 Hz. What is the tension in the wire?
   b. What is the temperature of the wire if its fundamental standing wave has frequency 460 Hz?
   For steel the coefficient of linear expansion is $\alpha = 1.2 \times 10^{-5}\ K^{-1}$ and Young's modulus is $Y = 20 \times 10^{10}$ Pa.
   Hint 1: if the steel wire is already under tension, would the temperature need to increase or decrease for the fundamental frequency to increase?
   Hint 2: The "F" in thermal stress equation is not the tension directly.
   This is why your favorite band needs to tune their instruments in every new venue.

4/20



$m = 2.50g$ (1)

$\rho_{steel} = 7800 \frac{kg}{m^3}$

$d = 0.400m$

a) $v = \lambda f$ (1) $\lambda \neq L$

$v = (0.400m)(440 \frac{1}{s})$

4/10 $v = 176 \frac{m}{s}$

$v = \sqrt{\frac{T}{\mu}}$ (1)

$v^2 = \frac{T}{\mu}$

$v^2 \mu = T$

$T = \frac{v^2 m}{L}$ (1)

$T = \frac{(176 \frac{m}{s})^2 (0.0025 kg)}{(0.400m)}$

$\boxed{T = 194\ N}$

b)?

0/10

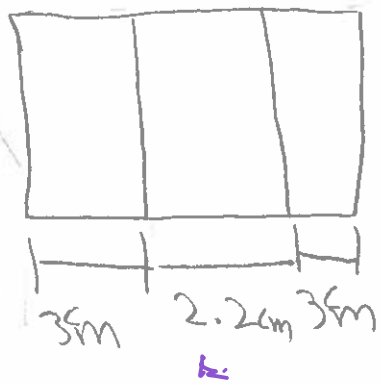
3/20

3. A carpenter builds an exterior house wall with a layer of wood 3.0 cm thick on the outside and a layer of Styrofoam insulation 2.2 cm thick on the inside wall surface. The wood has k = 0.080 W/m•K, and the Styrofoam has k = 0.027 W/m•K. The interior surface temperature is 19.0°C, and the exterior surface temperature is –10.0°C.
   a. What is the temperature at the plane where the wood meets the Styrofoam?
   b. What is the rate of heat flow per square meter through this wall?

1

$T_S = 19.0°C$

$T_W = -10.0°C$



1/10

a) Temp where wood meets styrofoam

$T = T_S - T_W$

$T = 29.0°C$ x

b) $\frac{dQ}{dt} = KA \frac{T_H - T_C}{L}$ 1

1/10

4. A thirsty nurse cools a 2.00 L bottle of a soft drink (mostly water) by pouring it into a large aluminum mug of mass 0.257 kg and adding 0.120 kg of ice initially at –15.0°C. If the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?
The specific heat of the aluminum $c_a = 910$ J/kg•K
For liquid water $c_w = 4190$ J/kg•K
For solid ice $c_i = 2100$ J/kg•K
Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K
Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

17/20

$2L \cdot \frac{10^{-3} m^3}{1 L} = 0.002 m$ (1)

$\rho_w = \frac{m_w}{V}$

$m_w = \rho_w V$

$m_w = (1.00 \times 10^3 \frac{kg}{m^3})(0.002 m^3)$

$m_w = 2$ kg (1)

$\sum Q = 0$

$Q_w + Q_{Al} + Q_{ice} = 0$

$Q_w = +m_w L_f + m_w c_w \Delta T$

$Q_{Al} = m_{Al} c_{Al} \Delta T$

$Q_{ice} = m_{ice} c_{ice} \Delta T$

$T_{iw} = 20 + 273.15 = 293.15$ K (1)

$T_{iice} = 258.15$ K

(−3)

$+ m_{ice} c_w (T - T_{iw})$

$+ m_{ice} L_f + m_w c_w (T - T_{iw}) + m_{Al} c_{Al} (T - T_{iAl}) + m_{ice} c_{ice} (T - T_{iice}) = 0$

$-m_w L_f = m_w c_w T - m_w c_w T_{iw} + m_{Al} c_{Al} T - m_{Al} c_{Al} T_{iAl} + m_{ice} c_{ice} T - m_{ice} c_{ice} T_{iice}$

$m_w c_w T_{iw} + m_{Al} c_{Al} T_{iAl} + m_{ice} c_{ice} T_{iice} - m_w L_f = m_w c_w T + m_{Al} c_{Al} T + m_{ice} c_{ice} T$

$$T = \frac{m_w c_w T_{iw} + m_{Al} c_{Al} T_{iAl} + m_{ice} c_{ice} T_{iice} - m_w L_f}{m_w c_w + m_{Al} c_{Al} + m_{ice} c_{ice}}$$

$$T = \frac{(2 kg)(4190 \frac{J}{kg \cdot K})(293.15 K) + (0.257 kg)(910 \frac{J}{kg \cdot K})(293.15 K) - (0.120 kg)(2100 \frac{J}{kg K})(258.15) - (2 kg)(3.35 \times 10^5)}{((2 kg)(4190) + (0.257)(910) + (0.120)(2100)) \frac{J}{K}}$$

$T = \frac{1790102.791 J}{8865 \frac{J}{K}}$

$\boxed{T = 202 K}$

8/20

5. A 2.00 MHz sound wave travels through a pregnant woman's abdomen and is reflected from the fetal heart wall of her unborn baby. The heart wall is moving toward the sound receiver as the heart beats. The reflected sound is then mixed with the transmitted sound, and 72 beats per second are detected. The speed of sound in body tissue is 1500 m/s. Calculate the speed of the fetal heart wall at the instant this measurement is made.

$f_S = 2.00\ MHz = 2.0 \times 10^6\ Hz$ 1

$f_B = f_S - f_L$ 3

$f_L = f_S - f_B$

$f_L = 1.99 \times 10^6\ Hz$? ✗

This is final frequency after reflection.

$f_L = \frac{V + V_L}{V} f_S$ 3 → $f'' = f_L ($

$f_L = \frac{f_S V + f_S V_L}{V}$

reflected wave?

$f_L V = f_S V + f_S V_L$

$\frac{f_L V - f_S V}{f_S} = V_L$

$V_L = \frac{(1.99 \times 10^6\ Hz)(1500\ \frac{m}{s}) - (2.0 \times 10^6\ Hz)(1500\ \frac{m}{s})}{2.00 \times 10^6\ Hz}$ 1

$V_L = 0.054\ \frac{m}{s}$

$\boxed{V_L = 5.4 \times 10^{-2}\ \frac{m}{s}}$ ✗

Exam 2
Physics 23
Fall 2024

Chapters 16 – 18

Name:

[redacted] 15/100

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$1\ atm = 1.013 \times 10^5\ Pa$
Gas constant: $R = 8.314\ J/mol{\bullet}K$
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15/100

1. Modern vacuum pumps make it easy to attain pressures of the order of 10^{-13} atm in the laboratory. Consider a volume of air and treat the air as an ideal gas.
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   c. Let compare this lab to astrophysical example, the Lagoon Nebula. The Lagoon Nebula is a cloud of hydrogen gas (molar mass of 2.016 g/mol) located 3900 light-years from the earth. The cloud is about 45 light-years in diameter and glows because of its high temperature of 7500 K. (The gas is raised to this temperature by the stars that lie within the nebula.) The cloud is also very thin; there are only 80 molecules per cubic centimeter. Find the gas pressure (in atmospheres) in the Lagoon Nebula. Compare it to the laboratory pressure in part (a).
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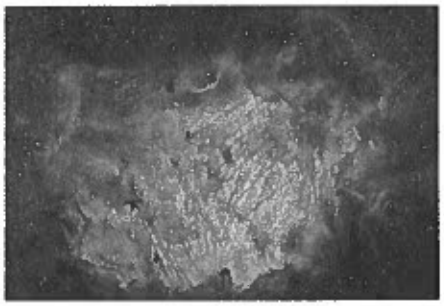
3/20



$300 = T_c + 273.15$
-273.15
$= 26.85$

Use 1 atm = 1.013×10^5 Pa, 1 $cm^3 = 1.00 \times 10^{-6}\ m^3$, $N_A = 6.022 \times 10^{23} particle/mole$

a) $pV = nRT$ (1)

$\Rightarrow pV = RT$ 8.314

$= n = \frac{RT}{pV} = \frac{(26.85)}{9.0\times10^{-14}(1.00\times10^{-6})}$ (1/2)

1/5 $= 2.48 \times 10^{21}$ (-1) units? # of molecules? (-1)

Not SI unit (-1/2)

× keep in Kelvin. (-1)

b) (1) $\frac{8.314(26.85)}{1.013\times10^5(1\times10^{-6})}$ (-1) (+1/2) (1/2)

2/5 $= 2203.66$ units? # of molecules?

c)

2. A steel wire has density 7800 kg/m^3 and mass 2.50 g. It is stretched between two rigid supports separated by 0.400 m.
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4/20

1

a) $f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$ 1

3/10

$(f_1 2L)^2 \mu = F$ 1

$30976 \cdot \frac{.025}{7800} = 0.01N$

1/10 b) $\frac{F}{A} = -Y\alpha\Delta T$ 1

5/20

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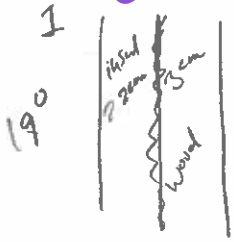

1

$$H = \frac{dQ}{dt} = k_A \frac{T_{HOT} - T_C}{L}$$ careful!

$$H = Ae\sigma T^4$$ for radiation

$$H_{hot} = Ae\sigma(T^4 - T_s^4)$$ ×

a) $k_w \frac{\Delta T_w}{L_w} = k_s \frac{\Delta T_s}{L_s}$ 1

5/10 ⇒ $0.08 \frac{19 - T}{3} = 0.027 \frac{T - (-10)}{2.2}$ 1/2 1 1/2

convert to meters

b) $H = Ae\sigma T^4$ ×

0/10

4. A thirsty nurse cools a 2.00 L bottle of a soft drink (mostly water) by pouring it into a large aluminum mug of mass 0.257 kg and adding 0.120 kg of ice initially at –15.0°C. If the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?

2/20

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Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

Q = mcΔT

1

1 Mug T = 20°C
m = 0.257kg

ice m = 1.20

5. A 2.00 MHz sound wave travels through a pregnant woman's abdomen and is reflected from the fetal heart wall of her unborn baby. The heart wall is moving toward the sound receiver as the heart beats. The reflected sound is then mixed with the transmitted sound, and 72 beats per second are detected. The speed of sound in body tissue is 1500 m/s. Calculate the speed of the fetal heart wall at the instant this measurement is made.

1/20

doppler's effect.

1

don't remember the eq

something like $\left(\frac{f_1 - f_2}{V_1 - V_2}\right)$ x

Exam 2
Physics 23
Fall 2024

Chapters 16 – 18

Name:

T[redacted] 73/100

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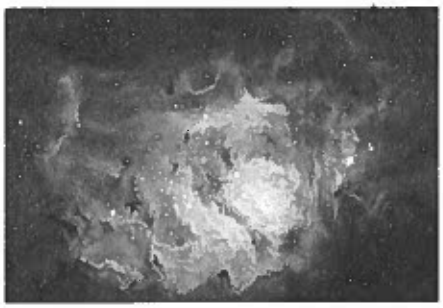
18/20



Use 1 atm = 1.013×10^5 Pa, 1 $cm^3 = 1.00 \times 10^{-6}\ m^3$,
$N_A = 6.022 \times 10^{23} particle/mole$

(a) $PV = nRT \Rightarrow n = \frac{PV}{RT} = \frac{(9.117\times10^{-9}\,Pa)(1.00\times10^{-6}\,m^3)}{(8.314\,J/mol\,K)(300\,K)} = 3.66\times10^{-18}\,mol$

5/5

$nN_A = \#$ molecules $\Rightarrow 3.66\times10^{-18}\,mol \times 6.022\times10^{23}\,mol^{-1} = 2.20\times10^{6}$ molecules ✓

(b) $n = \frac{PV}{RT} = \frac{(1.013\times10^{5}\,Pa)(1.\times10^{-6}\,m^3)}{(8.314\,J/mol\,K)(300\,K)} = 4.06\times10^{-5}\,mol$ c

5/5

$nN_A = \#$ molecules $\Rightarrow (4.06\times10^{-5}\,mol)(6.022\times10^{23}\,mol^{-1}) = 2.45\times10^{19}$ molecules

c) $PV = \frac{m}{M}RT \Rightarrow P\rho = \frac{RT}{M} \Rightarrow P = \frac{\rho RT}{M}$

compare? -2

6/6

$\rho = \frac{m}{V} = \left(\frac{(80\,molecules)}{6.022\times10^{23}\,mol^{-1}}\right) * \left(\frac{1}{1.00\times10^{-6}\,m^3}\right)(2.016\,g/mol) = 2.67\times10^{-16}\,g/m^3$

$P = \frac{(2.67\times10^{-16}\,g/m^3)(8.314\,J/mol\,K)(7500\,K)}{2.016\,g/mol} = 8.243\times10^{-12}\,Pa$ c $= 9.18\times10^{-17}$ atm

d) 2/2

No it does not seem realistic only 80 molecules per $1cm^3$ is incredibly small. I don't belive that that is enought to cause "turbulence", as the pressure is extremely small so there would be little to no resistance.

2. A steel wire has density 7800 kg/m^3 and mass 2.50 g. It is stretched between two rigid supports separated by 0.400 m.
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20/20

(a) $f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}} \Rightarrow F = (f_1 2L)^2 \mu \Rightarrow F_1 = [(440\ s^{-1})2(0.4\ cm)]^2\ 6.25\times10^{-3}\ kg/m$

10/10

$F_1 = 774.4N$

$\mu = \frac{mass}{length} = 6.25$

b) $\Delta L = \alpha_0 L_0 \Delta T \Rightarrow L - L_0 = \alpha L_0 \Delta T \Rightarrow L = L_0 + \alpha L_0 \Delta T = L_0 + \alpha L_0 (T_f - T_i)$

$f\lambda = V \qquad f_1 = \frac{V}{2L} \Rightarrow L = \frac{V}{f}$

$V = \pi r^2 h$

$\sigma = \frac{F}{A} = \qquad Stress = Y\left(\frac{\Delta L}{L_0}\right)$

$F_2 = 846.4N$

$\sqrt{\frac{3.21\times10^{-7} m^3}{\pi(8.8cm)}} = r$

$F_{stress} = Y\left(\frac{\Delta L}{L_0}\right)$

$F_{stress} = F_2 - F_1$

$r = 5.05\times10^{-4} m$

$F_{stress} = 72N$

$A_{Circle} = \pi r^2$

$= 8.02\times10^{-7} m^2$

$\frac{F}{A} = -Y\alpha(T_f - 20°C)$

10/10

$\frac{F}{A} = 8995600 Pa$

$T_f = -\frac{F}{A} \times \frac{1}{Y\alpha} + 20$

$= \frac{(8.99\times10^7)}{(2\times10^{10} Pa)(1.2\times10^{-5} K^{-1})} + 20°C$

$= -17.44°C$

$V = \pi r^2 h$

careful!

!

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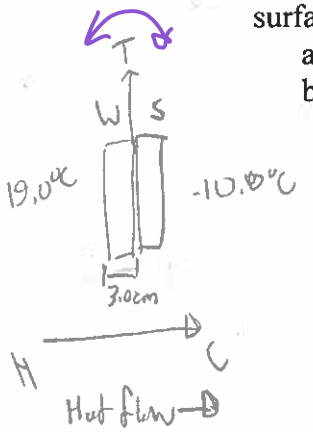

8/20

(a) $H_W = kA\frac{T_H - T}{L}$ ✓ $A_W = A_S$

$H_S = kA\frac{T - T_C}{L}$ ✓

b)? $H_{total} = H_1 + H_2$ ✗ 0/10

$H_{total} = k_W A \frac{T_H - T}{L} + k_S$ ✗ $\Rightarrow H_{total} = \frac{T_1 - T_3}{\frac{L_1}{k_1 A} + \frac{L_2}{k_2 A}}$

$H_S =$

$H_W = H_S$ ✓

8/10 $k_W \cancel{A} \frac{T_H - T}{L} = k_S \cancel{A} \frac{T - T_C}{L}$ ✓ ✓

T_C T_H careful!

$k_W \frac{(T_H - T)}{3cm} = k_S \frac{(T - T_C)}{2.2cm}$

$\frac{2.2cm}{3cm} \frac{k_W}{k_S}(T_H - T) = T - T_C$

$+ \frac{2.2cm}{3cm} \frac{k_W}{k_S} T_H = T\left(1 + \frac{2.2cm}{3cm}\right)$

4. A thirsty nurse cools a 2.00 L bottle of a soft drink (mostly water) by pouring it into a large aluminum mug of mass 0.257 kg and adding 0.120 kg of ice initially at –15.0°C. If the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?

17/20

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For solid ice c_i = 2100 J/kg•K
Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K
Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

m 2000 mL = 2000 cm^3

$V_w = 2 \times 10^{-3}\ m^3$

$m_w = 2\ kg$

$Q_{ice\ water} + Q_{ice} + Q_{Al} + Q_w = 0$

$Q_{ice} + Q_f + Q_{Al} + Q_w = 0$

$m_{ice} c_{ice} \Delta T + m_{ice} L_f + m_{Al} c_{Al} \Delta T + m_w c_w \Delta T + m_{ice} c_w (T_f) = 0$

$m_{ice} c_{ice} (15°C) + m_{ice} L_f + m_{Al} c_{Al} (T_f - 20°C) + m_w c_w (T_f - 20°C) + m_{ice} c_w T_f = 0$

−3

$m_{Al} c_{Al} T_f - m_{Al} c_{Al} 20°C + m_w c_w T_f - m_w c_w 20°C + m_{ice} c_w T_f = -m_{ice} c_{ice} 15 - m_{ice} L_f$

heat required to raise temp of defrosted ice water

$T_f (m_{Al} c_{Al} + m_w c_w + m_{ice} c_w) = m_{Al} c_{Al} 20°C + m_w c_w 20°C - m_{ice} c_{ice} 15 - m_{ice} L_f$

$$T_f = \frac{m_{Al} c_{Al} 20°C + m_w c_w 20°C - m_{ice} c_{ice} 15 - m_{ice} L_f}{m_{Al} c_{Al} + m_w c_w + m_{ice} c_w}$$

$+ (0.120\ kg)(4190\ J/kg\cdot K)(273)$

$$= \frac{(0.257\ kg)(910\ J/kg\cdot K)(293\ K) + (2\ kg)(4190\ J/kg\cdot K)(293\ K) - (0.12\ kg)(2100\ J/kg\cdot K)(15\ K) - (0.12\ kg)(3.35\ J/kg)}{(0.257\ kg)(910\ J/kg\cdot K) + (2\ kg)(4190\ J/kg\cdot K) + (0.12\ kg)(4190\ J/kg\cdot K)}$$

$= 272.0164\ K$ X

10/20

5. A 2.00 MHz sound wave travels through a pregnant woman's abdomen and is reflected from the fetal heart wall of her unborn baby. The heart wall is moving toward the sound receiver as the heart beats. The reflected sound is then mixed with the transmitted sound, and 72 beats per second are detected. The speed of sound in body tissue is 1500 m/s. Calculate the speed of the fetal heart wall at the instant this measurement is made.

1

$f_L = \frac{V+V_L}{V+V_S} f_A$ 3 3

5 !

$72 = f_A - f_L$ 3

2.00×10^6 Hz

$f_A = 2000072$ Hz

$V_S \neq 0$

$f_L = \frac{V+V_L}{V-V_L} f$

$\frac{f_L(V+\cancel{V_S})}{f_S} = V_L$

$\frac{(2000072\,\cancel{Hz})(1500\,m/s)}{2000072\,\cancel{Hz}} - 1500\,m/s = V_L$

2,000,000

$V_L = 0.054\,m/s$

There is two doppler effects happening due to the reflection. Both times the heart is moving towards the wall, once as an "receiver" and once as a "source".

Exam 2
Physics 23
Fall 2024

Chapters 16 – 18

Name:

Ta[redacted] 22.5/100

Your test has 5 problems, each worth 20 points.

Some useful constants:
Acceleration due to gravity: $g = 9.80\ m/s^2$
$1\ atm = 1.013 \times 10^5\ Pa$
Gas constant: $R = 8.314\ J/mol{\bullet}K$
$N_A = 6.022 \times 10^{23}\ particle/mole$

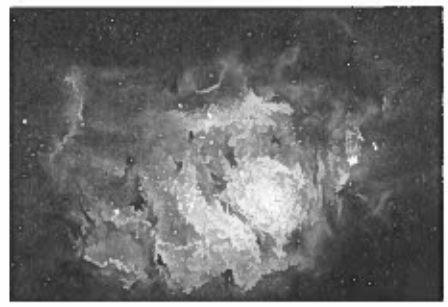
23.5/100

1. Modern vacuum pumps make it easy to attain pressures of the order of 10^{-13} atm in the laboratory. Consider a volume of air and treat the air as an ideal gas.

mol or molecules

   a. At a pressure of 9.00×10^{-14} atm and an ordinary temperature of 300.0 K, how many molecules are present in a volume of 1.00 cm^3?
   b. How many molecules would be present at the same temperature but at 1.00 atm instead?
   c. Let compare this lab to astrophysical example, the Lagoon Nebula. The Lagoon Nebula is a cloud of hydrogen gas (molar mass of 2.016 g/mol) located 3900 light-years from the earth. The cloud is about 45 light-years in diameter and glows because of its high temperature of 7500 K. (The gas is raised to this temperature by the stars that lie within the nebula.) The cloud is also very thin; there are only 80 molecules per cubic centimeter. Find the gas pressure (in atmospheres) in the Lagoon Nebula. Compare it to the laboratory pressure in part (a).
   d. Science-fiction films sometimes show starships being buffeted by turbulence as they fly through gas clouds such as the Lagoon Nebula. Does this seem realistic? Why or why not?

8/20



Use 1 atm = 1.013×10^5 Pa, 1 $cm^3 = 1.00 \times 10^{-6}\ m^3$,
$N_A = 6.022 \times 10^{23} particle/mole$

a) $PV = nRT$ (1)

$n = \frac{PV}{RT}$ convert to Pa. (+1/2)

$= \frac{(9.00\times10^{-14}\ atm)(1.00\times10^{-3})}{(8.314)(300)}$ (1)

3/5

$= 3.61\times10^{-20}\ mol\,(6.022\times10^{23})$

$= 2.17\times10^{4}$ molecules

b) $n = \frac{PV}{RT}$ (1) convert to Pa. (1/2)

$= \frac{(1.00\ atm)(1.00\times10^{-3})}{(8.314)(300)}$ (1)

3/5

$= 4.01\times10^{-7}(6.022\times10^{23}) = 2.42\times10^{17}$ molecules

c) $PV = nRT$

$T = 7500\ K$ (1)

$R = 8.314$

$M = 2.016\ g/mol$

3/10 $\rho = 80\ \frac{mol}{cm^3}$

Let $V = 1$ Liter why?

$= 2.4\ \frac{g}{L}$

$2.01(80) = 160\ \frac{g}{mL} = 160\times10^{-3}\ L\,(22.4\ \frac{g}{L}) = \frac{3.6\ g}{2.016\ \frac{g}{mol}} = 1.79$ mol

g/mol molecules/cm³

wrong

Should be very small

(1) need to find

$P = \frac{nRT}{V}$ (1)

$= \frac{(1.79)(8.314)(7500)}{(1\ L)} = 111407.6$ atm

d) No, the turbulence would need to be due to the medium the ship is in being very dense, at low pressures like in this model, the atmosphere is very thin, not massive

I [illegible] two weeks.
But execution is lacking.

My formula Sheet is missing also, I would love to retake this with a new one. I know you offer test corrections which I am grateful for. but I want to do well & prove I can poperly.

2. A steel wire has density 7800 kg/m^3 and mass 2.50 g. It is stretched between two rigid supports separated by 0.400 m.

Don't have eq's for transverse waves, only longit.

a. When the temperature of the wire is 20.0°C, the frequency of the fundamental standing wave for the wire is 440 Hz. What is the tension in the wire?

b. What is the temperature of the wire if its fundamental standing wave has frequency 460 Hz?

4/20

For steel the coefficient of linear expansion is $\alpha = 1.2 \times 10^{-5}\ K^{-1}$ and Young's modulus is $Y = 20 \times 10^{10}$ Pa.

Hint 1: if the steel wire is already under tension, would the temperature need to increase or decrease for the fundamental frequency to increase? — ~~increase~~ decrease

Hint 2: The "F" in thermal stress equation is not the tension directly. This is why your favorite band needs to tune their instruments in every new venue. →

Not just pass this course.

a) $\rho = 7800\ \frac{kg}{m^3}$ 1

$m = 2.5\ g$

1/10 $l = 0.400\ m$

$$T = \frac{(2.5 \times 10^{-3}\ kg)(0.400\ m)}{f^2\ (440\ Hz)^2}$$?

m L

x

$= 5.17 \times 10^{-4}\ N$ (not Correct)

b) ~~$\frac{F}{A} = -Y\alpha\Delta T$~~

3/10 $\Delta L = \alpha L_0 \Delta T$ 1

$\Delta L = 1.2\times10^{-5}(0.400)(20.0 - T_f)$

↳ need ΔL in terms of Tension

From part a, $t_i - T_f$ be $t_i > t_f$ by 1 c

frequency increasing

Assume $\Delta L = 2.4\times10^{-6}$ m for fun iguess

1 for lower temp

?

$$-\left[\frac{(2.4\times10^{-6}\ m)}{1.2\times10^{-5}(0.400)} - 20\right] = T_f = 26.5\ °C$$

5/20

3. A carpenter builds an exterior house wall with a layer of wood 3.0 cm thick on the outside and a layer of Styrofoam insulation 2.2 cm thick on the inside wall surface. The wood has k = 0.080 W/m•K, and the Styrofoam has k = 0.027 W/m•K. The interior surface temperature is 19.0°C, and the exterior surface temperature is –10.0°C.
   a. What is the temperature at the plane where the wood meets the Styrofoam?
   b. What is the rate of heat flow per square meter through this wall?

use fourier's law

Rusty on Heat Propogation

1

a) $Q = \frac{kA(T_{in} - T_{out})}{d}$

this is k for styrofoam... not wood

outside is associated w/ wood.

3/10

Let $A = 1\ m^2$

1

$Q = \frac{0.027(1)(T_{in} - (-263.15))}{0.03\ m} = 0.080(1)(T$

1

1 °C doesn't matter here

b) $Q = \frac{(0.08 - 0.027)(10 - (-10))}{0.032\ m}$?

Let $k = (k_{styro} + k_{wood})$

2/10

$Q = 43.031\ J$

$\frac{dQ}{dA} = \frac{43.031\ J}{1\ m^2} = 43.031\ \frac{J}{m^2}$

9

4. A thirsty nurse cools a 2.00 L bottle of a soft drink (mostly water) by pouring it into a large aluminum mug of mass 0.257 kg and adding 0.120 kg of ice initially at –15.0°C. If the soft drink and mug are initially at 20.0°C, what is the final temperature of the system, assuming that no heat is lost?
The specific heat of the aluminum c_a = 910 J/kg•K
For liquid water c_w = 4190 J/kg•K
For solid ice c_i = 2100 J/kg•K
- Latent heat of fusion of water: $L_f = 3.35 \times 10^5$ J/kg•K
- Density of water: $\rho = 1.00 \times 10^3$ kg/m^3

1.5/20

$Q = mL$ (1)

incorrect understanding the formula.

$Q = (0.257 + 0.120 + 2(1000\frac{g}{L}))(3.35 \times 10^5)$

$Q = 7.9 \times 10^5$ ✗

$Q = m_{tot}(c)\Delta T$ (1/2)

$\Delta T = \frac{Q}{m_{tot}(c)}$

$= \frac{7.9 \times 10^5}{(2.377)(4190)} = -80°$ no

Calorimeters

Find T_f

$Q_{surr} = m_{tot}(c)\Delta T$ ✗

$H = -Q_{surr}$ ✗

$\Delta H = \frac{-Q_{surr}}{m}, M, m$

Bigger problem is I don't remember how to calc specific heat

5. A 2.00 MHz sound wave travels through a pregnant woman's abdomen and is reflected from the fetal heart wall of her unborn baby. The heart wall is moving toward the sound receiver as the heart beats. The reflected sound is then mixed with the transmitted sound, and 72 beats per second are detected. The speed of sound in body tissue is 1500 m/s. Calculate the speed of the fetal heart wall at the instant this measurement is made.

5/20

$f_L = \frac{v + v_L}{v + v_s} f_s$

$f_s = 2.00 \times 10^6$ Hz

$v = 1500 \frac{m}{s}$

$v_s =$

$72 = \frac{1500 + v_L}{1500 + 0}(2.00 \times 10^6)$

$v_L = -1499.946$

1 $f_{beat} = f_a - f_b$

$72 = 2.00 \times 10^6$ Hz $- f_b$

1

$f_b = 1999928$ Hz

$= 1.99 \times 10^6$ Hz a

1 1

$1.99 \times 10^6 = \frac{1500 + 0^x}{1500 + v_s}(2.00 \times 10^6)$ c

1 −

$1500 + v_s = 1500.054$

$v_s = 0.05401 \frac{m}{s}$

HSIEH_JENNIFER

From: MENACHEKANIAN_EMIN
Sent: Tuesday, March 18, 2025 12:22 PM
To: FARIDIAN_FOROUZAN; HSIEH_JENNIFER; ROBERTS_KEVIN31
Subject: Re: Exam 2 kevin FF key with 5 graded exams ff

Hi Everyone,

Forouzan, thank you so much for grading this exam in such a thorough and complete manner for the sampling of students provided.

To be honest, it was really surprising to see such a large discrepancy in the grading for many of these students, particularly for Taber. How can the exam be a totally failing grade in one view, but a solid passing score in another?

Kevin, can you provide some additional feedback on this? For instance, can you describe, perhaps in some sort of a self-reflection, how your grading scheme led to such a different distribution of scores?

-Emin

From: FARIDIAN_FOROUZAN <FARIDIAN_FOROUZAN@smc.edu>
Date: Sunday, March 16, 2025 at 8:05 PM
To: HSIEH_JENNIFER <Hsieh_Jennifer@smc.edu>, MENACHEKANIAN_EMIN <Menachekanian_Emin@smc.edu>, ROBERTS_KEVIN31 <ROBERTS_KEVIN31@smc.edu>
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Hello everyone,

I looked at Kevin's old midterm and made a key and graded the given exams for comparison. Here is a pdf of the rubric, key, and the graded exams.

Forouzan

Sent from my iPad

HSIEH_JENNIFER

From: ROBERTS_KEVIN31
Sent: Friday, March 21, 2025 4:56 PM
To: MENACHEKANIAN_EMIN; FARIDIAN_FOROUZAN; HSIEH_JENNIFER
Subject: Re: Exam 2 kevin FF key with 5 graded exams ff

Hi everyone,

Thank you Forouzan for demonstrating the level of work I'd like to provide in grading my exams. Looking back at my grades, I was pressed for time and, when in doubt, was generous with my points. I felt guilty that I hadn't caught so many of my students' misunderstandings and errors. I fully acknowledge that this is unacceptable for the standard of grading at SMC. This semester, I will not get into the same situation with my grades. I have graded both of my exams within a week of giving them and (as Jenn suggested) I plan on writing out full solutions and writing out how many points were awarded along the way. I'm in the process of making them right now, and I plan on giving them to my students and the committee next week. I plan on thinking about what happened last semester and writing out a more thorough self-reflection for the committee.

Kevin

From: MENACHEKANIAN_EMIN <Menachekanian_Emin@smc.edu>
Sent: Tuesday, March 18, 2025 12:22 PM
To: FARIDIAN_FOROUZAN <FARIDIAN_FOROUZAN@smc.edu>; HSIEH_JENNIFER <Hsieh_Jennifer@smc.edu>; ROBERTS_KEVIN31 <ROBERTS_KEVIN31@smc.edu>
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I looked at Kevin's old midterm and made a key and graded the given exams for comparison. Here is a pdf of the rubric, key, and the graded exams.

Forouzan

Sent from my iPad

HSIEH_JENNIFER

From: ROBERTS_KEVIN31
Sent: Friday, March 21, 2025 5:51 PM
To: HSIEH_JENNIFER
Cc: FARIDIAN_FOROUZAN; MENACHEKANIAN_EMIN
Subject: Re: grade updates?
Attachments: Lab 1 Measurement Prelab.pdf; Lab 2 Constant acceleration Prelab.pdf

Hi everyone,

Yes, I was able to finish all of the exam 1 scores for each class and I've posted both of them now, which I was able to return both exam scores within a week.

I used Gradescope for both, so you can see the rubric that that generated for each exam. I'll also make a solution for each exam with the points that were given to each part as well.

I've graded a lab for each class, with comments, and I plan on releasing more grades very soon. (I've got two more labs to grade for each class, including labs that were turned in last week.

One reason I've been a bit slower grading labs is that I've been making more thorough pre-labs for some the labs (just the Physics 8/21 labs, but I plan on making some for the Physics 22 labs as well). As you suggested Jenn, I had them create the Excel spreadsheet before and test it with data that I provide them to "check" and see if they are setting up the labs. I'll attach my pre-labs that I've created so far. I've seen a large improvement of my labs that have been turned by my Physics 8 class. All students are completing all parts of the lab and I'm very happy with the work that they are turning in.

Lab 3 projectile Motion Prelab.pdf

From: HSIEH_JENNIFER <Hsieh_Jennifer@smc.edu>
Sent: Tuesday, March 18, 2025 1:23 PM
To: ROBERTS_KEVIN31 <ROBERTS_KEVIN31@smc.edu>
Cc: FARIDIAN_FOROUZAN <FARIDIAN_FOROUZAN@smc.edu>; MENACHEKANIAN_EMIN <Menachekanian_Emin@smc.edu>
Subject: grade updates?

Hi Kevin,

Just checking in on how you're doing with grading –

1. Were you able to finish and post P8, Exam 1 scores?
2. Did you use grade scope or pen & paper?
3. What about P22, Exam1? Were you able to post scores?
4. How are you doing on lab scores and returning their work with comments?

Thanks,

Jenn

HSIEH_JENNIFER

From: HSIEH_JENNIFER
Sent: Monday, May 12, 2025 11:53 AM
To: ROBERTS_KEVIN31
Cc: FARIDIAN_FOROUZAN; MENACHEKANIAN_EMIN
Subject: grading updates?

Hi Kevin,

I am writing to check in on your progress with grading this semester. I did a quick review of your gradebook this morning. Here is a summary of what I noted:

Physics 8

- Last exam scores to be posted, Exam 1
- Exam 2 was administered on April 9, scores are not posted yet
- Last lab scores to be posted, Experiment 4, scheduled to run March 24

Physics 22

- Last exam scores to be posted, Exam 1
- Exam 2 was administered on April 10, scores are not posted yet
- Last lab scores to be posted, Experiment 3, scheduled to run March 3

Can you please comment on why Exam 2 scores for both classes have not been posted yet? They were administered over a month ago.

Can you please comment on why no lab scores after those scheduled for March have been posted?

Thanks,

Jenn

HSIEH_JENNIFER

From: ROBERTS_KEVIN31
Sent: Friday, May 23, 2025 2:11 PM
To: HSIEH_JENNIFER
Subject: Re: grading updates?

Hi Jenn,

I have since posted my scores for Physics 8 exam 2 and **will** have Physics 22 exam 2 grades posted by Monday. And now that I've given Exam 3 for each, I plan to have grades posted on this upcoming Friday as a goal and **will** have them posted by the following Sunday. That way I will my students will have time to review and ask questions about their exams.

As for why my grades have fallen behind, I mentioned in my meetings with you and Emin that I had 5 students have crises of various types (a conference, extreme dysmenorrhea, hospitalization for a domestic violence incident, hospitalization for a suicide attempt), and while I do want to be equitable, I still have the responsibility to the rest of the class to grade my exams within a few week of giving them. I started off strong with grading within a week for exam 1 for each class. And I will make sure to get back to that standard for the rest of my career.

Thank you for checking in with me,

Kevin

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HSIEH_JENNIFER

From: HSIEH_JENNIFER
Sent: Monday, June 9, 2025 7:52 PM
To: ROBERTS_KEVIN31
Cc: MENACHEKANIAN_EMIN; FARIDIAN_FOROUZAN
Subject: Final exam clarification

Hi Kevin,

I received a panicked email from a student tonight. They said that they just found out that your Physics 22 exam will be given tomorrow, June 10, 3:30 pm – 6:00 pm.

I looked through everything you have posted on Canvas and in multiple locations it would indicate that your final is scheduled for Thursday, June 12 (syllabus & Final Exam assignment). I double checked with Ingrid on what day/time you reported to her. She said that you reported the exam is scheduled for Tuesday, June 10th, 3:30 pm to 6:30 pm.

From what I understand from the student, the change in schedule was only announced in person. I did a quick review of your Canvas shell and I did not find any attempt to correct the date and time in writing.

To summarize, if you follow the College "master" schedule, you should administer your Physics 22 exam on Tuesday, June 10, at 3:30 pm. However, you have posted on Canvas and in your syllabus that you would administer the exam on Thursday, June 12. You also made no attempt to correct the date in writing.

Can you please clarify what has happened here? Can you also please clarify how you expect students that might have missed the in-person class where you made the announcement to know that the exam is tomorrow? What happens when they show up to another instructors' final exam on Thursday?

Jenn

Jennifer M. Hsieh, Ph.D.
Department Chair, Physical Sciences
Professor of Chemistry
Santa Monica College

HSIEH_JENNIFER

From: ROBERTS_KEVIN31
Sent: Monday, June 9, 2025 8:18 PM
To: HSIEH_JENNIFER
Cc: MENACHEKANIAN_EMIN; FARIDIAN_FOROUZAN
Subject: Re: Final exam clarification

Hi Jenn,

Originally, I had the Thursday date on the syllabus because there was ambiguity in the master schedule on which date I should give the exam. At Ingrid's suggestion, I placed at "tentative" date of Thursday onto the syllabus. When the schedule was solidified. It turned out that Tuesday is the one that fit.

You are absolutely right, I should have sent an email immediately after I had the schedule solidified. I was planning on sending an email tonight reminding them (and I sent a version of that email tonight) If a student missed the in-person announcements (which I did make several, I believe I made at least 5 announcements), it was not sufficient. I should have also sent an email in writing too. That way, I would not have students showing up to another instructor's time on Thursday.

I should have communicated this change in more places.

Kevin

Get Outlook for iOS

From: HSIEH_JENNIFER <Hsieh_Jennifer@smc.edu>
Sent: Monday, June 9, 2025 7:51:40 PM
To: ROBERTS_KEVIN31 <ROBERTS_KEVIN31@smc.edu>
Cc: MENACHEKANIAN_EMIN <Menachekanian_Emin@smc.edu>; FARIDIAN_FOROUZAN <FARIDIAN_FOROUZAN@smc.edu>
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From what I understand from the student, the change in schedule was only announced in person. I did a quick review of your Canvas shell and I did not find any attempt to correct the date and time in writing.

To summarize, if you follow the College “master” schedule, you should administer your Physics 22 exam on Tuesday, June 10, at 3:30 pm. However, you have posted on Canvas and in your syllabus that you would administer the exam on Thursday, June 12. You also made no attempt to correct the date in writing.

Can you please clarify what has happened here? Can you also please clarify how you expect students that might have missed the in-person class where you made the announcement to know that the exam is tomorrow? What happens when they show up to another instructors’ final exam on Thursday?

Jenn

Jennifer M. Hsieh, Ph.D.
Department Chair, Physical Sciences
Professor of Chemistry
Santa Monica College

HSIEH_JENNIFER

From: ROBERTS_KEVIN31
Sent: Monday, June 9, 2025 8:27 PM
To: HSIEH_JENNIFER
Cc: MENACHEKANIAN_EMIN; FARIDIAN_FOROUZAN
Subject: Re: Final exam clarification

And I honestly forgot the Canvas date I had set. I have fixed it now.

Get Outlook for iOS

From: ROBERTS_KEVIN31 <ROBERTS_KEVIN31@smc.edu>
Sent: Monday, June 9, 2025 8:17:56 PM
To: HSIEH_JENNIFER <Hsieh_Jennifer@smc.edu>
Cc: MENACHEKANIAN_EMIN <Menachekanian_Emin@smc.edu>; FARIDIAN_FOROUZAN <FARIDIAN_FOROUZAN@smc.edu>
Subject: Re: Final exam clarification

Hi Jenn,

Originally, I had the Thursday date on the syllabus because there was ambiguity in the master schedule on which date I should give the exam. At Ingrid's suggestion, I placed at "tentative" date of Thursday onto the syllabus. When the schedule was solidified. It turned out that Tuesday is the one that fit.

You are absolutely right, I should have sent an email immediately after I had the schedule solidified. I was planning on sending an email tonight reminding them (and I sent a version of that email tonight) If a student missed the in-person announcements (which I did make several, I believe I made at least 5 announcements), it was not sufficient. I should have also sent an email in writing too. That way, I would not have students showing up to another instructor's time on Thursday.

I should have communicated this change in more places.

Kevin

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From: HSIEH_JENNIFER <Hsieh_Jennifer@smc.edu>
Sent: Monday, June 9, 2025 7:51:40 PM
To: ROBERTS_KEVIN31 <ROBERTS_KEVIN31@smc.edu>
Cc: MENACHEKANIAN_EMIN <Menachekanian_Emin@smc.edu>; FARIDIAN_FOROUZAN <FARIDIAN_FOROUZAN@smc.edu>
Subject: Final exam clarification

Hi Kevin,

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Jenn

Jennifer M. Hsieh, Ph.D.
Department Chair, Physical Sciences
Professor of Chemistry
Santa Monica College

Exam 1
Physics 22
Spring 2025

Chapters 21 – 23

Name:

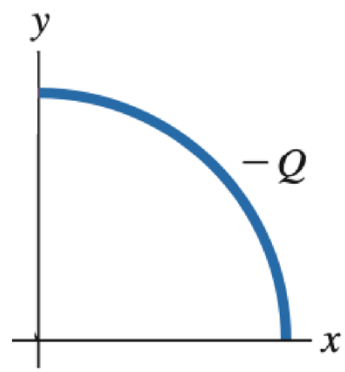
_____

Your test has 5 problems, each worth 20 points.

Some useful constants:
Acceleration due to gravity: g = 9.80 m/s^2
Charge of the electron $= e = 1.6022 \times 10^{-19}$ C
Mass of the electron $= m_e = 9.1094 \times 10^{-31}$ kg
Mass of the proton $= m_p = 1.6726 \times 10^{-27}$ kg
Mass of the neutron $= m_e = 1.6749 \times 10^{-27}$ kg
Coulomb's constant $= k_e = 8.988 \times 10^{9}$ N•m^2/C^2
Electric constant $= \epsilon_0 = 8.854 \times 10^{-12}$ C^2/N•m^2
1 eV $= 1.602 \times 10^{-19}$ J

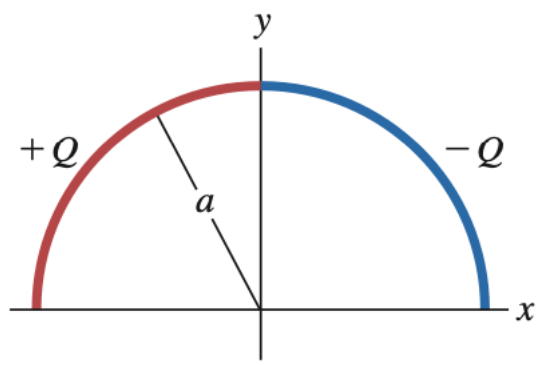
1. A proton is projected into a uniform electric field that points vertically upward and has magnitude E. The initial velocity of the proton has a magnitude v_0 and is directed at an angle α_0 **below** the horizontal.
    a. Find an express for the maximum distance h_{max} that the proton descends vertically below its initial elevation in terms of v_0, m_p, α_0, e, and E. Ignore gravitational forces.
    b. After what horizontal distance x_f does the proton return to its original elevation? (write in terms of v_0, m_p, α_0, e, and E)
    c. Sketch the trajectory of the proton.
    d. Find the numerical values of h_{max} and x_f if $E = 500$ N/C, $v_0 = 4.00 \times 10^5$ m/s, and $\alpha_0 = 30°$.

2. Negative charge $-Q$ is distributed uniformly around a quarter-circle of radius a that lies in the first quadrant, with the center of curvature at the origin. Assume that the quarter-circle has no thickness (i.e. that it is one-dimensional).



   a. Find the $x-$ and $y-$components of the net electric field at the origin.

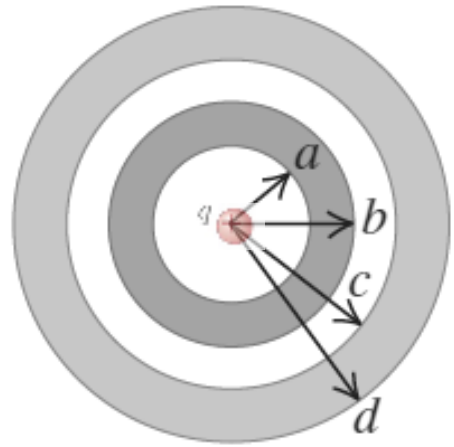
   b. Now consider adding another quarter-circle of radius a in the second quadrant of positive charge $+Q$ distributed uniformly. The result is a semicircle of radius a is in the first and second quadrants, with the center of curvature at the origin. Positive charge $+Q$ is distributed uniformly around the left half of the semicircle, and negative charge $-Q$ is distributed uniformly around the right half of the semicircle. What are the magnitude and direction of the net electric field at the origin produced by this distribution of charge?



   c. The net charge of the semicircle in part b is zero, why is the field at the origin NOT zero?

Workspace for problem 2.

3. A small conducting spherical shell with inner radius a and outer radius b is concentric with a larger conducting spherical shell with inner radius c and outer radius d. The inner shell has total charge $+2q$, and the outer shell has charge $-4q$. Additionally, there is a point charge $+q$ at the center of the shells.



   a. Calculate the electric field $\vec{E}$ (magnitude and direction) in terms of q and the distance r from the common center of the two shells for
      i. $r < a$
      ii. $a < r < b$
      iii. $b < r < c$
      iv. $c < r < d$
      v. $r > d$
      vi. Graph the radial component of $\vec{\boldsymbol{E}}$ as a function of r. (5 points)
   b. What is the total charge on the
      i. inner surface of the small shell (at a)
      ii. outer surface of the small shell; (at b)
      iii. inner surface of the large shell; (at c)
      iv. outer surface of the large shell (at d)

Workspace for problem 3.

4. A solid insulating sphere has radius R and carries a total positive charge Q distributed throughout its volume. The charge distribution has spherical symmetry but varies with radial distance r from the center of the sphere. The volume charge density $\rho(r)$ is

$$\rho(r) = 3\alpha\left(\frac{r}{2R}\right) \text{ for } r < \frac{R}{2}$$
$$\rho(r) = \alpha\left[1 - \left(\frac{r}{R}\right)^2\right] \text{ for } \frac{R}{2} \leq r \leq R$$
$$\rho(r) = 0 \text{ for } r > R$$

where α is a constant with units of C/m^3 .

a. Determine α in terms Q and R.
b. Using Gauss's law, derive an expression for the magnitude of the electric field as a function of r. Find $\vec{\boldsymbol{E}} = \vec{\boldsymbol{E}}(r)$ separately for all three regions. Express your answers in terms of Q.
c. What fraction of the total charge is contained within the region $R/2 \leq r \leq R$?
d. What is the magnitude of $\vec{\boldsymbol{E}}$ at $r = R/2$?
e. If an electron is released from rest at any point in any of the three regions, the resulting motion will be oscillatory but not simple harmonic. Why?

5. A proton and an alpha particle are released from rest when they are $b = 0.225$ nm $= 2.25 \times 10^{-10}$ m apart. The alpha particle (a helium nucleus) has essentially four times the mass and two times the charge of a proton.
    a. Set the alpha particle at the origin and the proton $b = 2.25 \times 10^{-10}$ m to the right on the x-axis. What is the potential $V = V(x)$ **along the $\boldsymbol{x}$-axis** (before they move)?
    b. What is the electric field $\vec{\boldsymbol{E}} = \vec{\boldsymbol{E}}(x)$ **along the $\boldsymbol{x}$-axis** (before they move)?
    c. Find the maximum speed and maximum acceleration of each of these particles. When do these maxima occur: just following the release of the particles or after a very long time?

Extra Space/Scratch work

TABLE OF INTEGRALS

Basic Forms

1. $\int u\,dv = uv - \int v\,du$

2. $\int u^n\,du = \dfrac{u^{n+1}}{n+1} + C, \quad n \neq -1$

3. $\int \dfrac{du}{u} = \ln|u| + C$

4. $\int e^u\,du = e^u + C$

5. $\int a^u\,du = \dfrac{a^u}{\ln a} + C$

6. $\int \sin u\,du = -\cos u + C$

7. $\int \cos u\,du = \sin u + C$

8. $\int \sec^2 u\,du = \tan u + C$

9. $\int \csc^2 u\,du = -\cot u + C$

10. $\int \sec u \tan u\,du = \sec u + C$

11. $\int \csc u \cot u\,du = -\csc u + C$

12. $\int \tan u\,du = \ln|\sec u| + C$

13. $\int \cot u\,du = \ln|\sin u| + C$

14. $\int \sec u\,du = \ln|\sec u + \tan u| + C$

15. $\int \csc u\,du = \ln|\csc u - \cot u| + C$

16. $\int \dfrac{du}{\sqrt{a^2 - u^2}} = \sin^{-1}\dfrac{u}{a} + C, \quad a > 0$

17. $\int \dfrac{du}{a^2 + u^2} = \dfrac{1}{a}\tan^{-1}\dfrac{u}{a} + C$

18. $\int \dfrac{du}{u\sqrt{u^2 - a^2}} = \dfrac{1}{a}\sec^{-1}\dfrac{u}{a} + C$

19. $\int \dfrac{du}{a^2 - u^2} = \dfrac{1}{2a}\ln\left|\dfrac{u+a}{u-a}\right| + C$

20. $\int \dfrac{du}{u^2 - a^2} = \dfrac{1}{2a}\ln\left|\dfrac{u-a}{u+a}\right| + C$

Forms Involving $\sqrt{a^2 + u^2}$, $a > 0$

21. $\int \sqrt{a^2 + u^2}\,du = \dfrac{u}{2}\sqrt{a^2 + u^2} + \dfrac{a^2}{2}\ln\left(u + \sqrt{a^2 + u^2}\right) + C$

22. $\int u^2\sqrt{a^2 + u^2}\,du = \dfrac{u}{8}(a^2 + 2u^2)\sqrt{a^2 + u^2} - \dfrac{a^4}{8}\ln\left(u + \sqrt{a^2 + u^2}\right) + C$

23. $\int \dfrac{\sqrt{a^2 + u^2}}{u}\,du = \sqrt{a^2 + u^2} - a\ln\left|\dfrac{a + \sqrt{a^2 + u^2}}{u}\right| + C$

24. $\int \dfrac{\sqrt{a^2 + u^2}}{u^2}\,du = -\dfrac{\sqrt{a^2 + u^2}}{u} + \ln\left(u + \sqrt{a^2 + u^2}\right) + C$

25. $\int \dfrac{du}{\sqrt{a^2 + u^2}} = \ln\left(u + \sqrt{a^2 + u^2}\right) + C$

26. $\int \dfrac{u^2\,du}{\sqrt{a^2 + u^2}} = \dfrac{u}{2}\sqrt{a^2 + u^2} - \dfrac{a^2}{2}\ln\left(u + \sqrt{a^2 + u^2}\right) + C$

27. $\int \dfrac{du}{u\sqrt{a^2 + u^2}} = -\dfrac{1}{a}\ln\left|\dfrac{\sqrt{a^2 + u^2} + a}{u}\right| + C$

28. $\int \dfrac{du}{u^2\sqrt{a^2 + u^2}} = -\dfrac{\sqrt{a^2 + u^2}}{a^2 u} + C$

29. $\int \dfrac{du}{(a^2 + u^2)^{3/2}} = \dfrac{u}{a^2\sqrt{a^2 + u^2}} + C$

Forms Involving $\sqrt{a^2 - u^2}$, $a > 0$

30. $\displaystyle\int \sqrt{a^2 - u^2}\, du = \frac{u}{2}\sqrt{a^2 - u^2} + \frac{a^2}{2}\sin^{-1}\frac{u}{a} + C$

31. $\displaystyle\int u^2\sqrt{a^2 - u^2}\, du = \frac{u}{8}(2u^2 - a^2)\sqrt{a^2 - u^2} + \frac{a^4}{8}\sin^{-1}\frac{u}{a} + C$

32. $\displaystyle\int \frac{\sqrt{a^2 - u^2}}{u}\, du = \sqrt{a^2 - u^2} - a\ln\left|\frac{a + \sqrt{a^2 - u^2}}{u}\right| + C$

33. $\displaystyle\int \frac{\sqrt{a^2 - u^2}}{u^2}\, du = -\frac{1}{u}\sqrt{a^2 - u^2} - \sin^{-1}\frac{u}{a} + C$

34. $\displaystyle\int \frac{u^2\, du}{\sqrt{a^2 - u^2}} = -\frac{u}{2}\sqrt{a^2 - u^2} + \frac{a^2}{2}\sin^{-1}\frac{u}{a} + C$

35. $\displaystyle\int \frac{du}{u\sqrt{a^2 - u^2}} = -\frac{1}{a}\ln\left|\frac{a + \sqrt{a^2 - u^2}}{u}\right| + C$

36. $\displaystyle\int \frac{du}{u^2\sqrt{a^2 - u^2}} = -\frac{1}{a^2 u}\sqrt{a^2 - u^2} + C$

37. $\displaystyle\int (a^2 - u^2)^{3/2}\, du = -\frac{u}{8}(2u^2 - 5a^2)\sqrt{a^2 - u^2} + \frac{3a^4}{8}\sin^{-1}\frac{u}{a} + C$

38. $\displaystyle\int \frac{du}{(a^2 - u^2)^{3/2}} = \frac{u}{a^2\sqrt{a^2 - u^2}} + C$

Forms Involving $\sqrt{u^2 - a^2}$, $a > 0$

39. $\displaystyle\int \sqrt{u^2 - a^2}\, du = \frac{u}{2}\sqrt{u^2 - a^2} - \frac{a^2}{2}\ln\left|u + \sqrt{u^2 - a^2}\right| + C$

40. $\displaystyle\int u^2\sqrt{u^2 - a^2}\, du = \frac{u}{8}(2u^2 - a^2)\sqrt{u^2 - a^2} - \frac{a^4}{8}\ln\left|u + \sqrt{u^2 - a^2}\right| + C$

41. $\displaystyle\int \frac{\sqrt{u^2 - a^2}}{u}\, du = \sqrt{u^2 - a^2} - a\cos^{-1}\frac{a}{|u|} + C$

42. $\displaystyle\int \frac{\sqrt{u^2 - a^2}}{u^2}\, du = -\frac{\sqrt{u^2 - a^2}}{u} + \ln\left|u + \sqrt{u^2 - a^2}\right| + C$

43. $\displaystyle\int \frac{du}{\sqrt{u^2 - a^2}} = \ln\left|u + \sqrt{u^2 - a^2}\right| + C$

44. $\displaystyle\int \frac{u^2\, du}{\sqrt{u^2 - a^2}} = \frac{u}{2}\sqrt{u^2 - a^2} + \frac{a^2}{2}\ln\left|u + \sqrt{u^2 - a^2}\right| + C$

45. $\displaystyle\int \frac{du}{u^2\sqrt{u^2 - a^2}} = \frac{\sqrt{u^2 - a^2}}{a^2 u} + C$

46. $\displaystyle\int \frac{du}{(u^2 - a^2)^{3/2}} = -\frac{u}{a^2\sqrt{u^2 - a^2}} + C$

Forms Involving $a + bu$

47. $$\int \frac{u\,du}{a+bu} = \frac{1}{b^2}\left(a + bu - a\ln|a+bu|\right) + C$$

48. $$\int \frac{u^2\,du}{a+bu} = \frac{1}{2b^3}\left[(a+bu)^2 - 4a(a+bu) + 2a^2\ln|a+bu|\right] + C$$

49. $$\int \frac{du}{u(a+bu)} = \frac{1}{a}\ln\left|\frac{u}{a+bu}\right| + C$$

50. $$\int \frac{du}{u^2(a+bu)} = -\frac{1}{au} + \frac{b}{a^2}\ln\left|\frac{a+bu}{u}\right| + C$$

51. $$\int \frac{u\,du}{(a+bu)^2} = \frac{a}{b^2(a+bu)} + \frac{1}{b^2}\ln|a+bu| + C$$

52. $$\int \frac{du}{u(a+bu)^2} = \frac{1}{a(a+bu)} - \frac{1}{a^2}\ln\left|\frac{a+bu}{u}\right| + C$$

53. $$\int \frac{u^2\,du}{(a+bu)^2} = \frac{1}{b^3}\left(a + bu - \frac{a^2}{a+bu} - 2a\ln|a+bu|\right) + C$$

54. $$\int u\sqrt{a+bu}\,du = \frac{2}{15b^2}(3bu - 2a)(a+bu)^{3/2} + C$$

55. $$\int \frac{u\,du}{\sqrt{a+bu}} = \frac{2}{3b^2}(bu - 2a)\sqrt{a+bu} + C$$

56. $$\int \frac{u^2\,du}{\sqrt{a+bu}} = \frac{2}{15b^3}(8a^2 + 3b^2u^2 - 4abu)\sqrt{a+bu} + C$$

57. $$\int \frac{du}{u\sqrt{a+bu}} = \frac{1}{\sqrt{a}}\ln\left|\frac{\sqrt{a+bu}-\sqrt{a}}{\sqrt{a+bu}+\sqrt{a}}\right| + C, \quad \text{if } a > 0$$
$$= \frac{2}{\sqrt{-a}}\tan^{-1}\sqrt{\frac{a+bu}{-a}} + C, \qquad \text{if } a < 0$$

58. $$\int \frac{\sqrt{a+bu}}{u}\,du = 2\sqrt{a+bu} + a\int \frac{du}{u\sqrt{a+bu}}$$

59. $$\int \frac{\sqrt{a+bu}}{u^2}\,du = -\frac{\sqrt{a+bu}}{u} + \frac{b}{2}\int \frac{du}{u\sqrt{a+bu}}$$

60. $$\int u^n\sqrt{a+bu}\,du = \frac{2}{b(2n+3)}\left[u^n(a+bu)^{3/2} - na\int u^{n-1}\sqrt{a+bu}\,du\right]$$

61. $$\int \frac{u^n\,du}{\sqrt{a+bu}} = \frac{2u^n\sqrt{a+bu}}{b(2n+1)} - \frac{2na}{b(2n+1)}\int \frac{u^{n-1}\,du}{\sqrt{a+bu}}$$

62. $$\int \frac{du}{u^n\sqrt{a+bu}} = -\frac{\sqrt{a+bu}}{a(n-1)u^{n-1}} - \frac{b(2n-3)}{2a(n-1)}\int \frac{du}{u^{n-1}\sqrt{a+bu}}$$

Trigonometric Forms

63. $\int \sin^2 u\, du = \frac{1}{2}u - \frac{1}{4}\sin 2u + C$

64. $\int \cos^2 u\, du = \frac{1}{2}u + \frac{1}{4}\sin 2u + C$

65. $\int \tan^2 u\, du = \tan u - u + C$

66. $\int \cot^2 u\, du = -\cot u - u + C$

67. $\int \sin^3 u\, du = -\frac{1}{3}(2 + \sin^2 u)\cos u + C$

68. $\int \cos^3 u\, du = \frac{1}{3}(2 + \cos^2 u)\sin u + C$

69. $\int \tan^3 u\, du = \frac{1}{2}\tan^2 u + \ln|\cos u| + C$

70. $\int \cot^3 u\, du = -\frac{1}{2}\cot^2 u - \ln|\sin u| + C$

71. $\int \sec^3 u\, du = \frac{1}{2}\sec u \tan u + \frac{1}{2}\ln|\sec u + \tan u| + C$

72. $\int \csc^3 u\, du = -\frac{1}{2}\csc u \cot u + \frac{1}{2}\ln|\csc u - \cot u| + C$

73. $\int \sin^n u\, du = -\frac{1}{n}\sin^{n-1} u \cos u + \frac{n-1}{n}\int \sin^{n-2} u\, du$

74. $\int \cos^n u\, du = \frac{1}{n}\cos^{n-1} u \sin u + \frac{n-1}{n}\int \cos^{n-2} u\, du$

75. $\int \tan^n u\, du = \frac{1}{n-1}\tan^{n-1} u - \int \tan^{n-2} u\, du$

76. $\int \cot^n u\, du = \frac{-1}{n-1}\cot^{n-1} u - \int \cot^{n-2} u\, du$

77. $\int \sec^n u\, du = \frac{1}{n-1}\tan u \sec^{n-2} u + \frac{n-2}{n-1}\int \sec^{n-2} u\, du$

78. $\int \csc^n u\, du = \frac{-1}{n-1}\cot u \csc^{n-2} u + \frac{n-2}{n-1}\int \csc^{n-2} u\, du$

79. $\int \sin au \sin bu\, du = \frac{\sin(a-b)u}{2(a-b)} - \frac{\sin(a+b)u}{2(a+b)} + C$

80. $\int \cos au \cos bu\, du = \frac{\sin(a-b)u}{2(a-b)} + \frac{\sin(a+b)u}{2(a+b)} + C$

81. $\int \sin au \cos bu\, du = -\frac{\cos(a-b)u}{2(a-b)} - \frac{\cos(a+b)u}{2(a+b)} + C$

82. $\int u \sin u\, du = \sin u - u\cos u + C$

83. $\int u \cos u\, du = \cos u + u \sin u + C$

84. $\int u^n \sin u\, du = -u^n \cos u + n\int u^{n-1}\cos u\, du$

85. $\int u^n \cos u\, du = u^n \sin u - n\int u^{n-1}\sin u\, du$

86. $\int \sin^n u \cos^m u\, du = -\frac{\sin^{n-1} u \cos^{m+1} u}{n+m} + \frac{n-1}{n+m}\int \sin^{n-2} u \cos^m u\, du$

$= \frac{\sin^{n+1} u \cos^{m-1} u}{n+m} + \frac{m-1}{n+m}\int \sin^n u \cos^{m-2} u\, du$

Inverse Trigonometric Forms

87. $\int \sin^{-1} u\, du = u \sin^{-1} u + \sqrt{1-u^2} + C$

88. $\int \cos^{-1} u\, du = u \cos^{-1} u - \sqrt{1-u^2} + C$

89. $\int \tan^{-1} u\, du = u \tan^{-1} u - \frac{1}{2}\ln(1+u^2) + C$

90. $\int u \sin^{-1} u\, du = \frac{2u^2-1}{4}\sin^{-1} u + \frac{u\sqrt{1-u^2}}{4} + C$

91. $\int u \cos^{-1} u\, du = \frac{2u^2-1}{4}\cos^{-1} u - \frac{u\sqrt{1-u^2}}{4} + C$

92. $\int u \tan^{-1} u\, du = \frac{u^2+1}{2}\tan^{-1} u - \frac{u}{2} + C$

93. $\int u^n \sin^{-1} u\, du = \frac{1}{n+1}\left[u^{n+1}\sin^{-1} u - \int \frac{u^{n+1}\, du}{\sqrt{1-u^2}}\right], \quad n \neq -1$

94. $\int u^n \cos^{-1} u\, du = \frac{1}{n+1}\left[u^{n+1}\cos^{-1} u + \int \frac{u^{n+1}\, du}{\sqrt{1-u^2}}\right], \quad n \neq -1$

95. $\int u^n \tan^{-1} u\, du = \frac{1}{n+1}\left[u^{n+1}\tan^{-1} u - \int \frac{u^{n+1}\, du}{1+u^2}\right], \quad n \neq -1$

Rubric For Physics 22 Exam 1

Question 1

Select many

1 part a

- **+2.5** Find the acceleration of the proton from Newton's 2nd Law, OR set up potential and kinetic energy equation
- **+2.0** almost acceleration
- **+2.5** Set up constant acceleration kinematic equation 3 (or the energy equivalent)
- **+1.75** incorrect set-up of eq 3
- **+1.5** solve for y_{max}
- **+2.0** attempt to find y_{max}

2 part b

- **+2.5** Set-up constant a kinematic equation 2 in y to find the time t_f
- **+2.5** Find the time t_f
- **+1.5** find $x_f = v_{0x}t_f = v_0 cos\alpha_0 t_f$
- **-1.5** solved for x at h_{max} not when y =0
- **+1.0** attempt to find t_f
- **+1.0** found x_f with an incorrect equation

3 part c

- **+1.5** Draw electric field up
- **+1.5** proton is initially angle down α_0 below horizontal
- **+2.0** proton's path is a parabola
- **+0.0** no sketch

4 part d

- **+1.0** numerical value of h_{max}
- **+1.0** numerical value of x_f
- **+1.0** attempted both numerical caculations
- **+0.5** attempted one numerical caculation

Question 2

1 part a

- +2.0
  set up the dQ
- +4.0
  set up the dE (mag)
- +1.5
  set up dE_x
- +1.5
  set up dE_y
- +2.0
  integrate to find E_x and E_y
- +1.0
  attempt to set up the dQ
- +1.5
  attempt to set up the dE
- +1.0
  attempt to integrate
- -0.5
  extra factor of a
- +1.0
  attempt to set up components
- -0.25
  E_x is positive

2 part b

- +3.0
  note that the quarter circle has the same E_x but opposite E_y
- +2.0
  Add the E_x and $E_y = 0$
- +1.5
  some attempt
- +0.0
  incorrect
- +3.0
  thought that the E_x would cancel instead of E_y

3 Part c

- +4.0
  Correct reasoning
- +2.0
  good reasoning
- +1.0
  beginning reasoning
- +0.0
  incorrect

Question 3

1 part a

- **+1.8** Part i, correct E magnitude and direction
- **+0.8** Part i, correct E direction, incorrect E magnitude
- **+1.8** Part ii, correct E magnitude and direction
- **+0.0** part ii incorrect
- **+1.8** Part iii, correct E magnitude and direction
- **+0.8** Part iii, correct E direction, incorrect E magnitude
- **+0.5** attempt iii
- **+1.8** Part iv, correct E magnitude and direction
- **+0.0** part iv incorrect
- **+1.8** Part v, correct E magnitude and direction
- **+1.0** Part v, correct E magnitude; incorrect E direction
- **+0.8** Part v, correct E direction, incorrect E magnitude
- **+0.5** attempt v
- **-0.1** no $\hat{r}$ for i
- **-0.1** no $\hat{r}$ for iii
- **-0.1** no $\hat{r}$ for v

2 Graph of E(r)

- **+0.35** $E \to \infty$ as $r \to 0$
- **+0.35** E field is positive where $r < a$
- **+0.5** E field is proportional to $\frac{1}{r^2}$ where $r < a$
- **+0.35** E field is zero $a < r < b$
- **+0.35** E field is positive $b < r < c$
- **+0.5** E field is proportional to $\frac{1}{r^2}$ $b < r < c$ (and its value at $r = b$ must be less than 3 time the value at $r = a$)
- **+0.35** E field is zero $c < r < d$
- **+0.35** E field is negative $r > d$
- **+0.5** E field is proportional to $\frac{1}{r^2}$ $r > d$ (and its value at $r = d$ must be less than the magnitude the value at $r = a$)
- **+0.35** the field is discontinuous at $r = a$ because of the charge at a
- **+0.35** the field is discontinuous at $r = b$ because of the charge at b
- **+0.35** the field is discontinuous at $r = c$ because of the charge at c
- **+0.35** the field is discontinuous at $r = d$ because of the charge at d
- **+0.0** no attempt at graphing $E(r)$

3 part b

- **+1.5** Part i, charge at a: correct magnitude and sign
- **+1.0** Part i, charge at a: correct magnitude and incorrect sign
- **+0.5** Part i, charge at a incorrect attempt
- **+1.5** Part ii, charge at b correct magnitude and sign
- **+1.0** Part ii, charge at b: correct magnitude and incorrect sign
- **+0.5** Part ii, charge at b incorrect attempt
- **+1.5** Part iii, charge at c correct magnitude and sign
- **+1.0** Part iii, charge at c: correct magnitude and incorrect sign
- **+0.5** Part iii, charge at c incorrect attempt
- **+1.5** Part iv, charge at d correct magnitude and sign
- **+1.0** Part iv, charge at d: correct magnitude and incorrect sign
- **+0.5** Part iv, charge at d incorrect attempt
- **+0.0** incorrect

Question 4

1 part a

- +0.5 Set-up integral for the Q between $0 < r < R/2$
- +0.5 Set-up integral for the Q between $R/2 < r < R$
- +2.0 Find total Q
- +1.0 solve for α
- +0.5 incorrectly assumed that the charge density was uniform for α
- +1.5 good attempt to find Q
- +0.5 good attempt for α

2 part b

- +3.0 Find E for $0 < r < R/2$
- -0.5 math error for $0 < r < R/2$
- +3.0 Find E for $R/2 < r < R$
- -0.5 math error for $R/2 < r < R$
- -1.5 Need to have Q_i (the Q within $r < R/2$) as a separate integral
- +3.0 Find E for $r > R$
- -0.5 math error for $r > R$
- +0.0 Incorrectly assume that $E = 0$ for $r > R$ because $\rho = 0$ there
- +0.5 some attempt to find E
- +0.0 no part b
- +1.5 ome set up of the integrals for E
- +3.0 Attempted to find E in each region without taking integrals for $Q_{enclosed}$

3 part c

- +3.0 find the fraction of Q $R/2 < r < R$
- +1.5 Made progress with the fraction
- +0.75 Set up an equation for part c
- +0.0 no part c
- -0.5 calc error

4 part d

- +2.0 Correctly evaluate E at $r = R/2$
- +0.0 no part d
- +0.5 attempt part d
- -0.5 calc error

5 part e

- +2.0 correctly explain that the force attractive but is never proportional to $-r$, necessary for simple harmonic motion
- +0.0 no part e
- +0.0 no discussion about the causes of simple harmonic motion
- +0.5 Any mention that the electric field is nonuniform
- +1.0 Note that the electric field changes with some factor of r
- +0.5 state that simple harmonic motion need the force (or field) to be proportional to $-r$

Question 5

1 part a

+2.0
correctly find the potential

+1.0
attempt to find the potential

2 part b

+2.0
Correctly find the electric field

+1.0
attempt to find the electric field

+0.0
no attempt

3 part c max a

+2.0
max acceleration is just after release

+2.0
correctly find force

+1.0
attempt to find the force

+2.0
correctly find acceleration for the proton

+2.0
correctly find acceleration for the alpha particle

+1.0
attempt to find the acceleration fo the alpha particle

+1.0
attempt to find the acceleration fo the proton

+0.0
no attempt to find max a

+0.5
wrote $F = ma$

+1.0
attempt to explain when max a is

+0.5
incorrect use of constant a kinematic equations

4 part d

+2.0
Correctly evaluate E at $r = R/2$

+0.0
no part d

+0.5
attempt part d

-0.5
calc error

5 part e

+2.0
correctly explain that the force attractive but is never proportional to $-r$, necessary for simple harmonic motion

+0.0
no part e

+0.0
no discussion about the causes of simple harmonic motion

+0.5
Any mention that the electric field is nonuniform

+1.0
Note that the electric field changes with some factor of r

+0.5
state that simple harmonic motion need the force (or field) to be proportional to $-r$

Exam 2
Physics 22

Chapters 24–26

Name:

_____

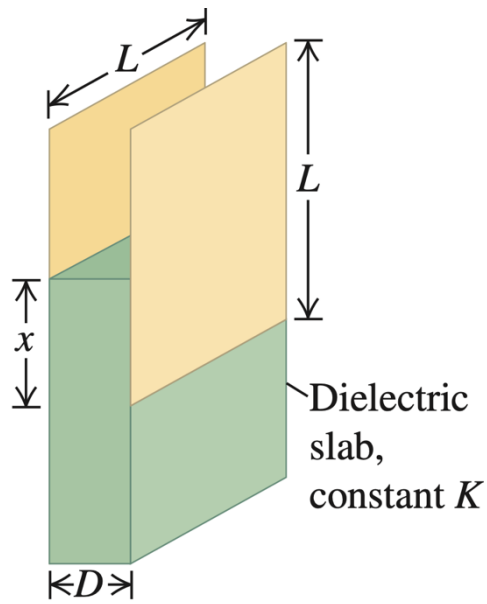
Student ID:

_____

Your test has 8 problems, for a total of 100 points.

Some useful constants:
Acceleration due to gravity: g = 9.80 m/s^2
Charge of the electron $= e = 1.6022 \times 10^{-19}$ C
Mass of the electron $= m_e = 9.1094 \times 10^{-31}$ kg
Mass of the proton $= m_p = 1.6726 \times 10^{-27}$ kg
Mass of the neutron $= m_e = 1.6749 \times 10^{-27}$ kg
Coulomb's constant $= k_e = 8.988 \times 10^{9}$ N•m^2/C^2
Electric constant $= \epsilon_0 = 8.854 \times 10^{-12}$ C^2/N•m^2
1 eV $= 1.602 \times 10^{-19}$ J

1. (15 points) Two square conducting plates with sides of length L are separated by a distance D. A dielectric slab with constant K with dimensions $L \times L \times D$ is inserted a distance x into the space between the plates, as shown.



   a. Find the capacitance C of this system.

   b. Suppose that the capacitor is connected to a battery that maintains a constant potential difference V between the plates. If the dielectric slab is inserted an additional distance dx into the space between the plates, find an expression for the change in stored energy dU.

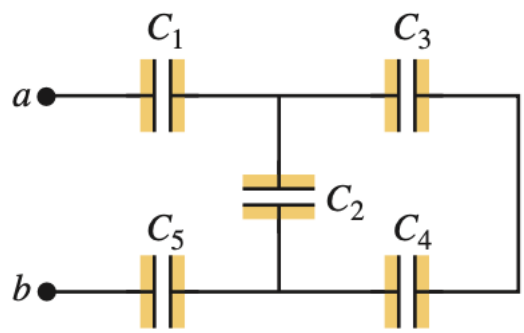
   c. Suppose that before the slab is moved by dx, the plates are disconnected from the battery, so that the charges on the plates remain constant. Determine the magnitude of the charge on each plate and then find the change in energy dU when the slab is moved dx farther into the space between the plates.

   d. If F is the force exerted on the slab by the charges on the plates, then dU should equal the work done against this force to move the slab a distance dx. Thus $dU = -F\,dx$. What is the electric force on the slab in part (b)? What is the electric force on the slab in part (c)? Is the slab pulled in or pushed out?

   e. Are parts (b) and (c) consistent? If they are they, explain why. If they are not the same, explain why. (Hint: This method does not require knowledge of the nature of the fringing field.)

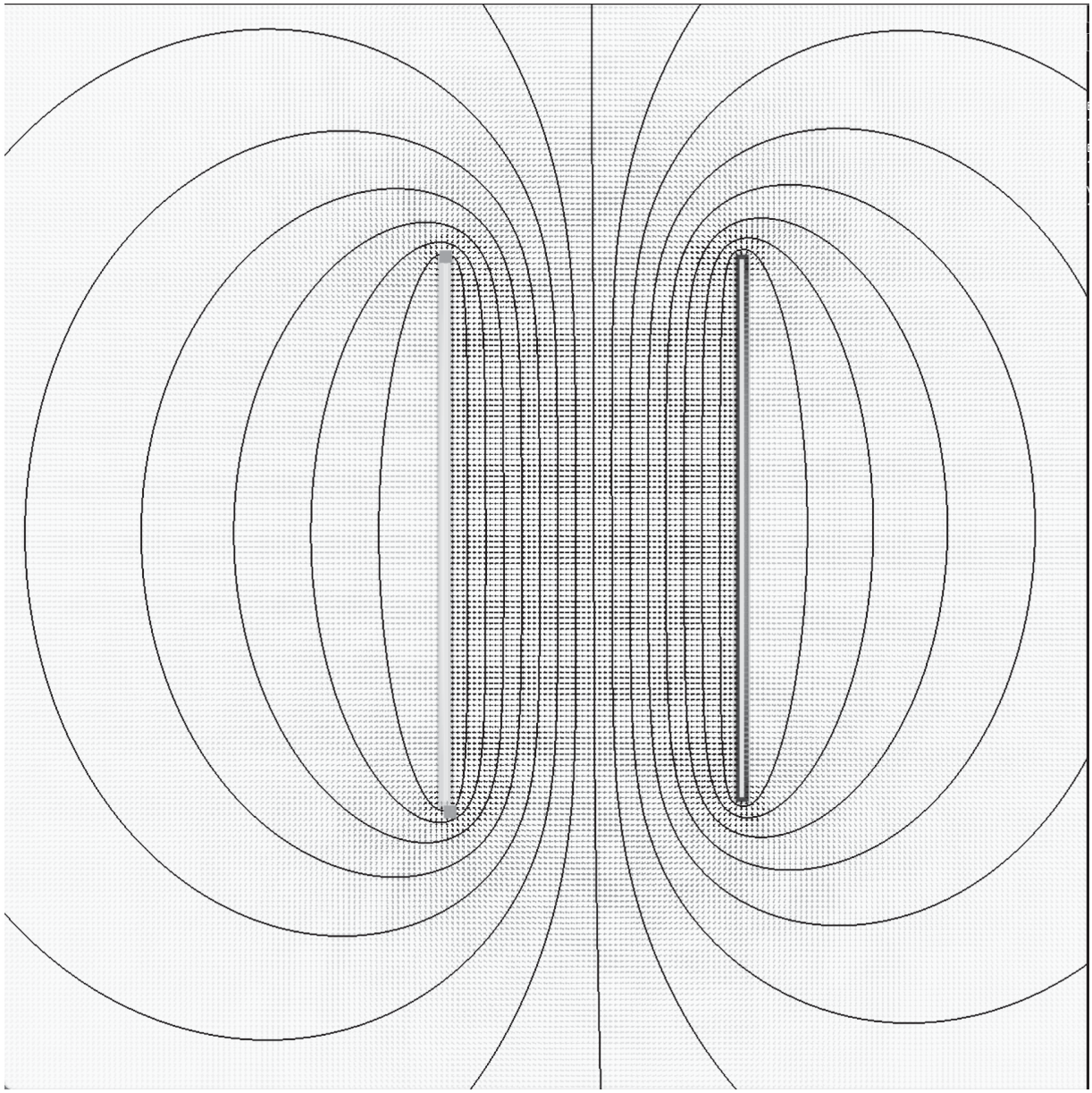
Scratch work for question 1

2. (8 points) In the figure, $C_1 = C_5 = 8.4$ mF and $C_2 = C_3 = C_4 = 4.2$ mF. The applied potential is $V_{ab} = 220$ V.
   a. What is the equivalent capacitance of the network between points a and b?
   b. Calculate the charge on each capacitor and the potential difference across each capacitor.

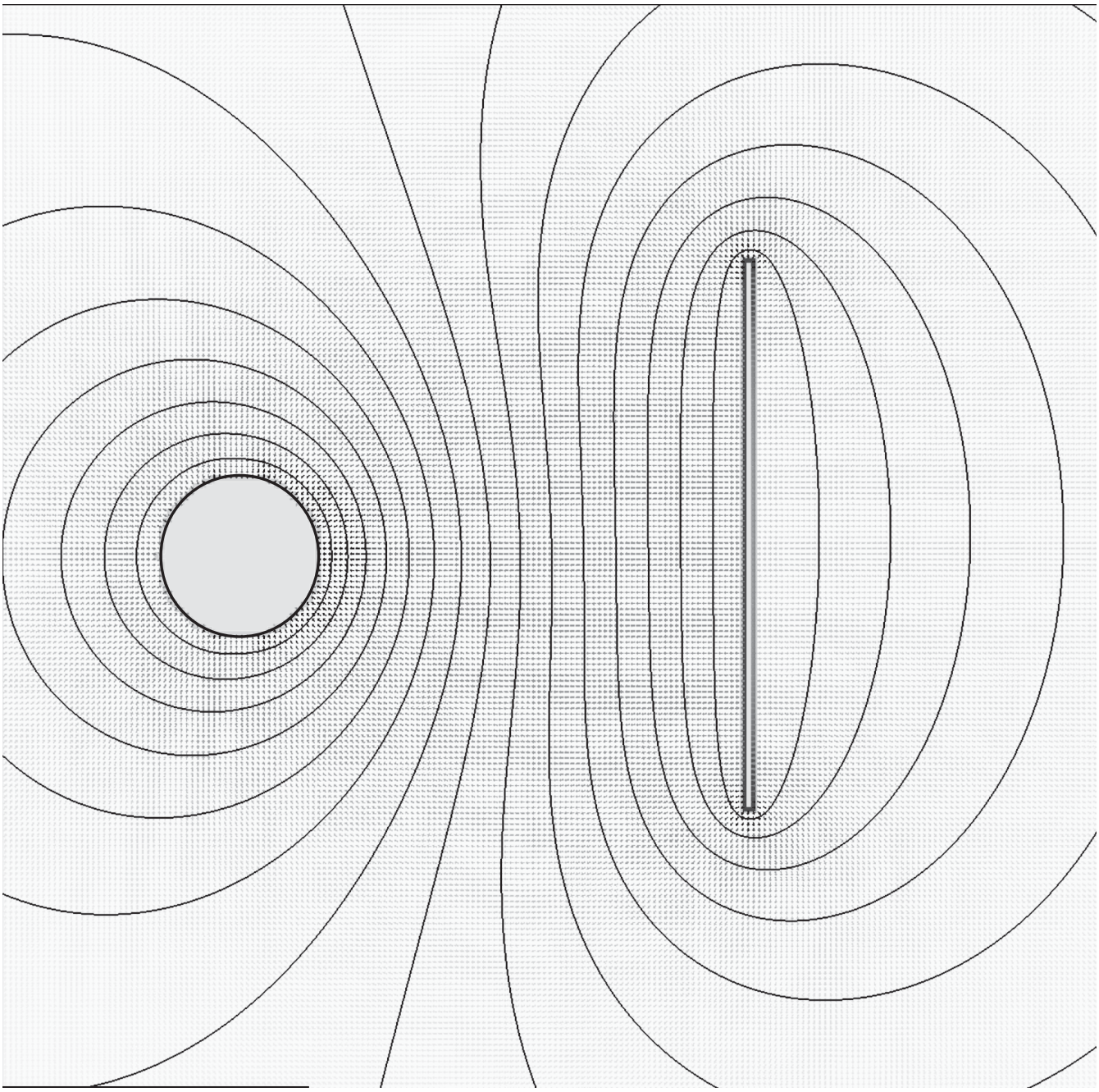


Scratch work for question 2

3. (20 points)
   a. Consider the follow potential field lines that were sampled around and between two metal plates, the left one held at 0 V and right one held at 100 V. Label each of the electric potentials (assuming that each line is equally spaced). Draw accurate electric field lines.



b. Now consider hollow metal cylinder held at 0 V and metal plate held at 100 V. Label each of the electric potentials and accurately draw electric field lines.

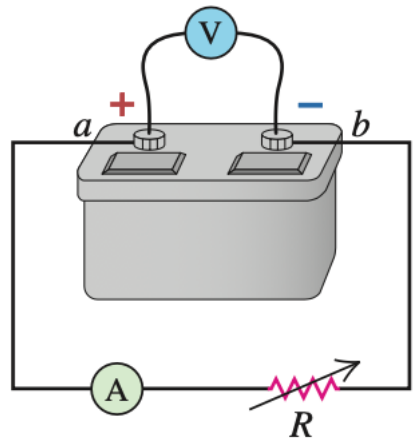


c. How are the electric field lines and potentials related to each other?
d. In the above diagrams on the previous two pages, where are the electric fields stronger? How can you tell? (Be specific!)
e. How does the potential inside the cylinder vary? What is the electric field inside of the cylinder? Be specific in your explanation.

4. (12 points) A cylindrical copper ($\rho = 1.72 \times 10^{-8}\ \Omega \cdot \mathrm{m}$) cable, 1.50 km long, is connected across a 220.0 V potential difference.
    a. What should be its diameter so that it produces heat at a rate of 90.0 W?
    b. What is the electric field inside the cable under these conditions?
    c. As a cost-saving measure, you want to have your wire only radiate 45.0 W, using the same amount of material and holding the same potential difference. What would the dimensions of the wire be in this case, and is this feasible?

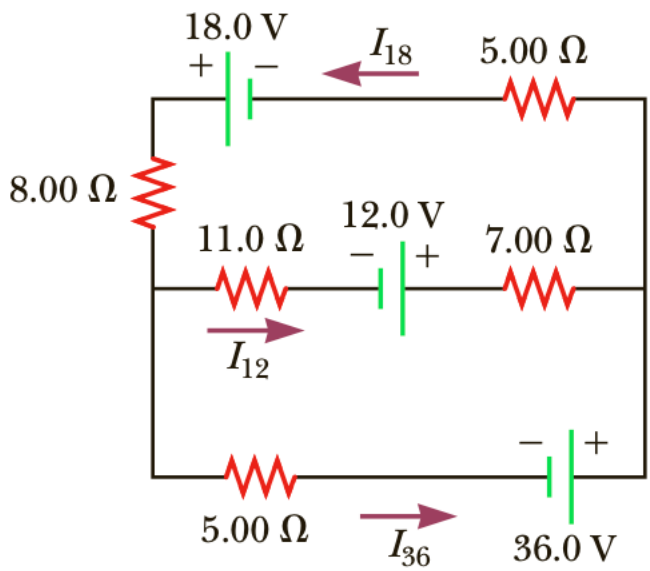
Scratch work for question 4

5. (12 points) In the circuit shown in the figure, R is a variable resistor whose value ranges from 0 to ∞, and a and b are the terminals of a battery that has an emf $\mathcal{E} = 15.0$ V and an internal resistance of 4.00 Ω. The ammeter and voltmeter are idealized meters. As R varies over its full range of values, what will be the largest and smallest readings of
   a. the voltmeter and
   b. the ammeter?
   c. Sketch qualitative graphs of the readings of both meters as functions of R.



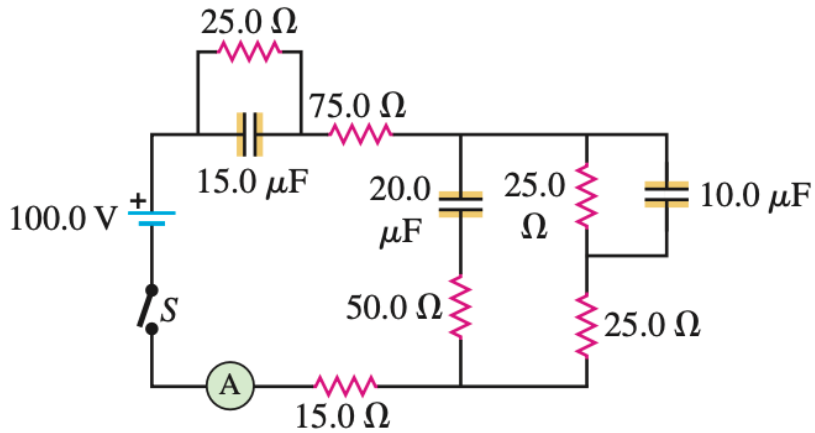
Scratch work for question 5

6. (12 points) Use Kirchhoff's rules to find the current through each branch as indicated. Comment on the significance if any answers are negative.



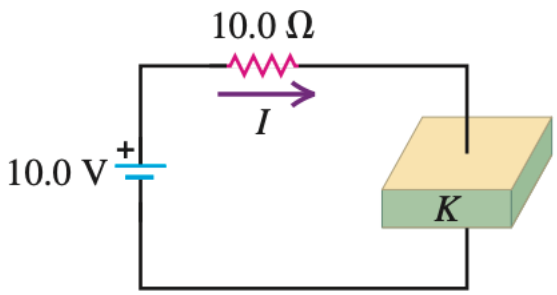
Scratch work for question 6

7. (6 points) In the circuit in the figure, the capacitors are initially uncharged, the battery has no internal resistance, and the ammeter is idealized. Find the ammeter reading
   a. just after the switch S is closed.
   b. after S has been closed for a very long time.



Scratch work for question 7

8. (15 points) An R-C circuit is constructed as shown in the figure. The capacitor has 2.00 cm × 2.00 cm square plates that are parallel and separated by 3.00 mm, and it is fully charged before a dielectric is inserted. At time t = 0, a 2.00 cm × 2.00 cm × 3.00 mm slab with dielectric constant $K = 12.0$ is slid between the plates as shown.



a. How much charge is on the upper plate before the slab is inserted?
b. What is the current I immediately after the slab is inserted?
c. How much energy is stored in the capacitor immediately after the slab is inserted?
d. By how much does the energy in the capacitor increase from that value after a long time has passed?
e. How much total energy is eventually supplied by the battery after the slab is inserted?

Hint: Determine the current as a function of time, then integrate the power delivered to the battery $\int_0^\infty Vi(t)dt$.

f. How much energy is dissipated by the resistor?
g. Check that energy supplied to the capacitor and resistor is equal the energy drawn from the battery. (Energy conservation)

Scratch work for question 8

Scratch work for question 8

Rubric For Physics 22 Exam 2

Question 1

1 General

- **+2.0** Realize that the system can be considered as two capacitors in parallel, one with Area $L(L-x)$ and air, and the other with Area Lx and dielectric
- **+2.0** $C = \frac{K\epsilon_0 A}{d}$
- **+1.0** Realize that the system can be considered as two capacitors in parallel, one with air and the other with a dielectric, but have the dimensions wrong
- **+0.5** Got one of the capacitor dimensions correct
- **+1.0** Realize that the system can be considered as two capacitors in parallel, but didn't have one with air, and the other with dielectric

2 Part A

- **+2.0** Correctly find $C = \frac{\epsilon_0 L}{D}[L + (K-1)x]$
- **+1.0** attempt to find C
- **-0.25** Forgot ϵ_0

3 Part B

- **+2.0** Correctly find dU (with battery)
- **+0.5** Set up dU
- **-0.5** Forgot the air part
- **+1.5** attempt to find dU

4 Part C

- **+3.0** Correctly find dU (no battery)
- **+1.5** attempt to find dU
- **+0.5** set up dU

5 Part D

- **+2.0** Find the correct expression and sign. Then note that the force is opposite to the motion dx so the slab is pushed out
- **+1.5** Have the correct expression but wrong sign (and hence assume that it will be pulled in)
- **+0.5** Correctly state that the slab is pushed out (with no justification)
- **+1.5** Find the correct expression and sign, but no discussion of the sign
- **+0.75** Set up finding F
- **+1.25** Find the correct expression and sign. But incorrectly assume that the slab is pulled in
- **+1.0** Find an expression and sign, but no discussion of the sign
- **+0.0** not relevant

6 Part E

- **+2.0** Correctly note that when the battery is connected, the plate plus slab are not an isolated system. So parts B and C should have opposite signs
- **+1.0** Incorrect, because you incorrect got B and C the same
- **+0.0** No proof
- **+0.0** Not what the question was asking

Question 2

1 Part a find equivalent capacitances

- **+0.6** Found C_{34} correctly
- **+0.6** Found C_{234} correctly
- **+0.6** Found C_{eq} correctly
- **+0.3** incorrectly set up the C_{eq} as if all the capacitor were in series
- **+0.3** incorrectly set up the C_{eq} as if all the capacitor were in parallel
- **-0.1** order of magnitude incorrect
- **+0.2** Calculated C_{34} as if the capacitors were parallel, not series
- **+0.2** Calculated C_{234} as if the capacitors were series, not parallel
- **+0.2** Calculated C_{eq} as if the capacitors were parallel, not series
- **-0.1** calc error
- **+0.6** incorrectly set up the C_{eq} equations

2 Part b: Find Q on each capacitor

- **+0.5** found Q_{eq}
- **+0.75** Note that $Q_{eq} = Q_1 = Q_5 = Q_{234}$. Capacitors in series have the same charge and the same as the equivalent capacitor. And found the charge
- **+0.5** Found Q_2
- **+0.75** Note that $Q_{34} = Q_3 = Q_4$. Capacitors in series have the same charge and the same as the equivalent capacitor. And found the charge
- **+0.25** Note $Q_1 = Q_5$, but incorrectly (or didn't) calculate the charge
- **+0.25** Note $Q_3 = Q_4$, but incorrectly (or didn't) calculate the charge
- **-0.1** missing units (x2)
- **+0.2** Correctly noted that $Q = CV$ but incorrectly calculated all charges (only applied if Q, W, E, or R are not)
- **-0.1** calc error

3 Part b: Find V across each capacitor

- **+0.1** Note that $V_1 = V_5$
- **+0.4** Find V_1
- **+0.4** Find V_5
- **+0.7** Note that $V_2 = V_{34} = V_{234}$. Both branches of a parallel circuit have equivalent potential and the same as the equivalent circuit
- **+0.5** Find $V_{234} = V_2$
- **+0.6** Note that $V_{234} = V_3 + V_4$
- **+0.5** Note that $V_3 = V_4$
- **+0.5** Found V_3 and V_4

Question 3

1 part a

- **+2.5** Field lines make right angles to potential lines
- **+2.0** Field lines make nearly straight lines across between the plates
- **+1.0** Field lines spread out (fringe) outside of the plates
- **+1.0** Field lines point toward the left plate
- **+1.0** Field lines point away from the right plate
- **-1.0** incorrectly add arrow to the potential curves
- **-1.0** not enough field lines
- **+0.0** no field lines drawn

2 part b

- **+2.5** Field lines make right angles to potential lines
- **+1.0** Field lines spread out from the cylinder
- **+1.0** Field lines spread when far from the plate
- **+1.0** near the centerline the field lines are straighter
- **+1.0** Field lines point toward the left cylinder
- **+1.0** Field lines point away from the right plate
- **-1.0** incorrectly add arrows forthe potential curves
- **-1.0** not enough field lines
- **+0.0** no field lines drawn

3 part c

- **+2.0** correctly note that electric field lines are perpendicular to each other OR note that the electric field is the gradient of the potential
- **+0.5** sometimes true, not fully true here
- **+0.0** incorrect

4 part d

- **+2.0** Correctly note that the electric field is stronger where the field lines are denser AND the potential lines change more rapidly
- **+1.0** Specifically correct, but not generally
- **+0.0** incorrect

5 part e

- **+1.0** Correctly note that the potential inside the cylinder is constant so the electric field inside is 0
- **+0.0** incorrect
- **+0.5** correct, but you can be more specific

Question 4

1 Part A

- **+1.5** $P = \frac{V^2}{R}$
- **+1.5** $R = \frac{\rho L}{A}$
- **+1.5** $A = \pi r^2 = \pi (D/2)^2$
- **+4.0** Correctly solve for D
- **-1.0** Arithmetic error
- **+2.0** Solved for for with algebra errors

2 Part B

- **+2.0** $E = V/L$ (correct)
- **+0.0** Incorrectly assumed that this is perfect conductor
- **+1.0** Incorrectly did $E = V/r$
- **+0.5** Some step up of what E should be
- **-0.5** incorrect order of magnitude

3 Part C

- **+1.5** correctly found the new D
- **+0.5** didn't properly resize the terms

Question 5

1 Part A: Voltmeter

- **+1.25** Correctly found the max V_{ab} is when $R \to \infty$
- **+1.25** Correctly found the min V_{ab} is when $R = 0$

2 Part B: ammeter

- **+1.25** Correctly found the max I is when $R = 0$
- **+1.25** Correctly found the min I is when $R \to \infty$

3 Part c V_{ab} vs R

- **+1.0** The graph has a horizontal asymptote as $R \to \infty$ at 15 V
- **+2.0** The graph has a $-\frac{1}{R/r+1}$ dependence, increasing quickly near $R = 0$ and slope decreases
- **+0.5** The graph passes through (0,0)
- **+1.0** The graph is curved, but the concavity is in the wrong direction

4 Part c I vs R

- **+1.0** The graph has a horizontal asymptote as $R \to 0$, $I \to 0$
- **+2.0** The graph has a $\frac{1}{R/r+1}$ dependence, initially negative slope near $R = 0$ and slope magnitude decreases
- **+0.5** The graph passes through (0, 3.75 A)
- **+1.5** The graph has a $\frac{1}{R}$ dependence, initially negative slope near $R = 0$ and slope magnitude decreases (incomplete)
- **+1.0** The graph is curved, but the concavity is in the wrong direction

Question 6

1 **+12.0**

Correct

2 **+11.0**

Found all currents, but didn't comment on why I_{12} was negative

3 **+4.0**

Set up the equations but didn't make much progress

4 **+10.0**

Found three (incorrect) currents with small math errors

5 **+2.0**

some set up

6 **+7.0**

Found three (incorrect) currents with significant math errors

Question 7

1 Part A: Just after the switch is closed

+1.5
Recognize that capacitors act like short circuits just after the switch is closed

+0.75
Find R_{eq} of the simplified network

+0.75
Find I

+0.0
no part a

+0.35
Correctly did the series part of R_{eq} but not the parallel part

+0.0
Incorrectly assumed that all resistors would be in series

+0.0
Incorrectly assumed that all resistors would be in parallel

-0.5
incorrectly assume part A network applied to B

2 Part B: After the switch is closed for a long time

+1.5
Recognize that capacitors act like open circuits after the switch is closed for a long time

+0.75
Find R_{eq} of the simplified network

+0.75
Find I

+0.0
no part b

-0.5
incorrectly assume part B network applied to A

Question 8

1 Part A

- **+0.75** Correctly find Q_0
- **+0.25** Correctly find C but not Q
- **-0.1** Wrong order of magnitude
- **-0.2** wrong units

2 Part B

- **+1.0** Find the voltage across the capacitor V_C just after the dielectric is inserted
- **+1.0** Set up a Kirchhoff loop for current I
- **+0.75** Solve for current I
- **+0.5** attempt to find the voltage across the capacitor just after the dielectric is inserted
- **-0.25** arithmetic error
- **+0.0** incorrectly assume that the voltage across the capacitor drops to zero after the dielectric is inserted
- **+0.0** incorrectly assume that the voltage across the capacitor matches that of the resistor
- **+0.0** incorrectly applied the charging capacitor in an RC circuit equation
- **-0.5** forgot the dielectric constant on C

3 Part C

- **+1.5** Correctly find energy just after the dielectric is inserted
- **+1.0** incorrectly find the energy after it is fully charged after a long time
- **+1.0** Change the capacitance in the equation, but not V
- **+0.0** incorrect
- **+0.25** set up equation (and didn't apply correctly)
- **+0.5** calculate the energy just before the dielectric is inserted

4 Part D

- **+1.5** Correctly found the final energy stored
- **+0.5** Correctly found ΔU
- **+0.0** incorrect
- **+0.25** set up equation (and didn't apply correctly)

5 Part E

- **+1.0** Wrote down the current in a charging RC circuit
- **+1.0** Set up the integral for the energy supplied by the battery
- **+2.0** Found the energy supplied by the battery
- **+0.0** Didn't apply the correct limits to the integral

6 Part F

- **+1.0** Set up the integral for the energy dissipated by the resistor
- **+2.0** Found the energy dissipated by the resistor

7 Part G

- **+1.0** Check that energy conservation holds

Exam 2
Physics 22

Chapters 27–29

Name:

_____

Student ID:

_____

Your test has 8 problems, for a total of 100 points.

Some useful constants:

Acceleration due to gravity: g = 9.80 m/s^2

Charge of the electron = $e = 1.6022 \times 10^{-19}$ C

Mass of the electron = $m_e = 9.1094 \times 10^{-31}$ kg

Mass of the proton = $m_p = 1.6726 \times 10^{-27}$ kg

Mass of the neutron = $m_e = 1.6749 \times 10^{-27}$ kg

Coulomb's constant = $k_e = 8.988 \times 10^9$ N•m^2/C^2

Electric constant = $\epsilon_0 = 8.854 \times 10^{-12}$ C^2/N•m^2

Vacuum permeability = $\mu_0 = 1.25663706212 \times 10^{-6} \frac{\mathrm{N}}{\mathrm{A}^2} \approx 4\pi \times 10^{-7}$ N/A^2

Speed of light = $c = 299792458$ m/s

1 eV = 1.602×10^{-19} J

1. (13 points) An alpha particle (a He nucleus, containing two protons and two neutrons and having a mass of 6.64×10^{-27} kg) traveling horizontally at 35.6 km/s enters a uniform, vertical, 1.80 T magnetic field.
    a. What is the diameter of the path followed by this alpha particle?

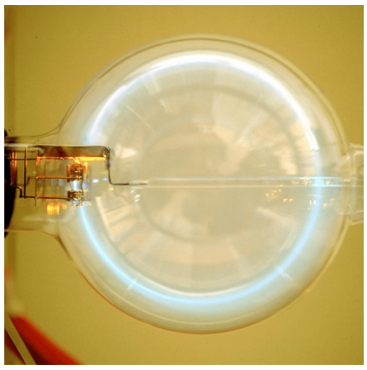
    b. What effect does the magnetic field have on the speed of the particle?

    c. What are the magnitude and direction of the acceleration of the alpha particle while it is in the magnetic field?

    d. Explain why the speed of the particle does not change even though an unbalanced external force acts on it.

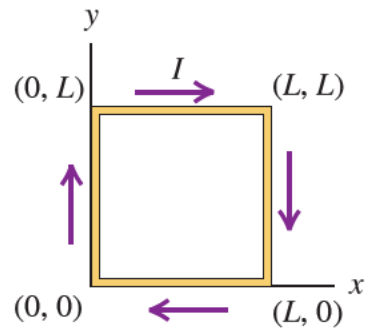
Scratch work for question 1

2. (15 points) You measure the charge-to-mass ratio q/m for a particle with positive charge in the following way: The particle starts from rest, is accelerated through a potential difference ΔV, and attains a velocity with magnitude v. It then enters a region of uniform magnetic field B = 0.200 T that is directed perpendicular to the velocity; the particle moves in a path that is an arc of a circle of radius R. You measure R as a function of ΔV.
    a. What is q/m in terms of velocity and potential difference?
    b. What is the velocity in terms R and B?
    c. You plot your data as R^2 (in units of m^2) versus ΔV (in V) and find that the values lie close to a straight line that has slope 1.04×10^{-6} m^2/V. What is the value of q/m for this particle?
    d. Can you make a guess at what particle it might be?



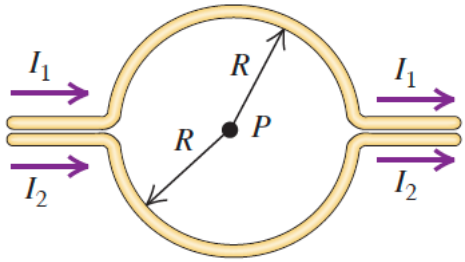
Scratch work for question 2

3. (16 points) The net force on a current loop in a uniform magnetic field is zero. But what if $\vec{\mathbf{B}}$ is not uniform? The figure shows a square loop of wire that lies in the xy-plane. The loop has corners at (0, 0), (0, L), (L, 0), and (L, L) and carries a constant current I in the clockwise direction. The magnetic field has no x-component but has both y- and z-components: $\vec{\mathbf{B}} = \left(\frac{B_0 z}{L}\right)\hat{\mathbf{j}} + \left(\frac{B_0 y}{L}\right)\hat{\mathbf{k}}$, where B_0 is a positive constant.



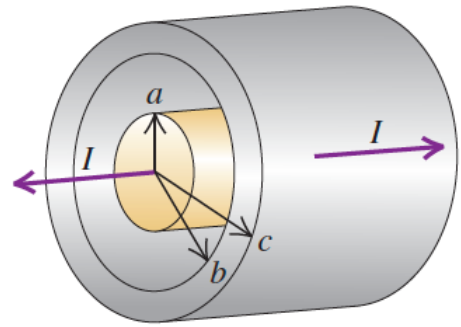
a. Sketch the magnetic field lines in the yz-plane.
b. Find the magnitude and direction of the magnetic force exerted on each of the sides of the loop by integrating.
c. Find the magnitude and direction of the net magnetic force on the loop.

4. (13 points) Calculate the magnitude of the magnetic field at point P in terms of R, I_1, and I_2. What does your expression give when $I_1 = I_2$?



Scratch work for question 4

5. (8 points) A solid conductor with radius a is supported by insulating disks on the axis of a conducting tube with inner radius b and outer radius c. The central conductor and tube carry equal currents I in opposite directions. The currents are distributed uniformly over the cross sections of each conductor. Derive an expression for the magnitude of the magnetic field
   a. at points inside the central, solid conductor $r < a$
   b. at points outside the central, solid conductor but inside the tube $a < r < b$
   c. at points inside the tube $b < r < c$
   d. at points outside the tube $r > c$.



Scratch work for question 5

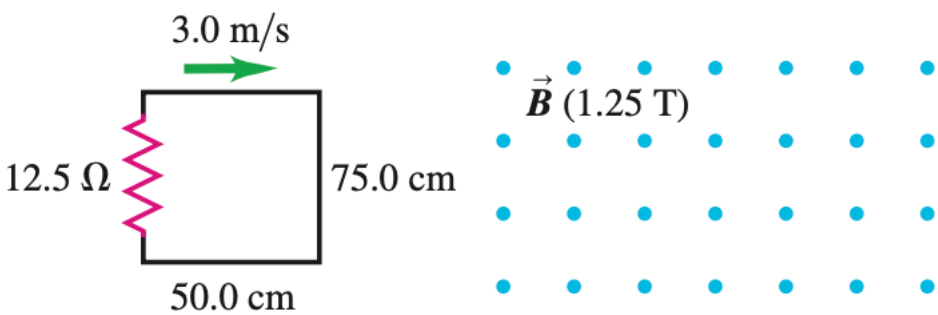
6. (9 points) A solenoid is designed to produce a magnetic field of 0.0270 T at its center. It has radius 1.40 cm and length 40.0 cm, and the wire can carry a maximum current of 12.0 A.
    a. What minimum number of turns per unit length must the solenoid have?
    b. What total length of wire is required?

Scratch work for question 6

7. (12 points) A rectangular circuit is moved at a constant velocity of 3.0 m/s into, through, and then out of a uniform 1.25 T magnetic field, as shown. The magnetic-field region is considerably wider than 50.0 cm.

   Find the magnitude and direction (clockwise or counter- clockwise) of the current induced in the circuit as it is:

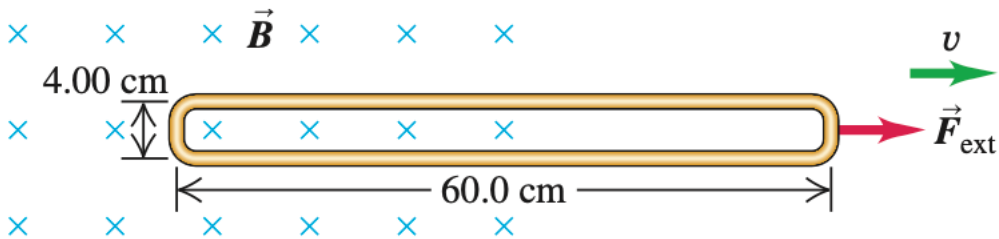
   a. going into the magnetic field
   b. totally within the magnetic field, but still moving
   c. moving out of the field
   d. Sketch a graph of the current in this circuit as a function of time, including the preceding three cases.



Scratch work for question 7

8. (14 points) A very long, rectangular loop of wire can slide without friction on a horizontal surface. Initially the loop has part of its area in a region of uniform magnetic field that has magnitude $B = 2.90$ T and is perpendicular to the plane of the loop. The loop has dimensions 4.00 cm by 60.0 cm, mass 24.0 g, and resistance $R = 5.00 \times 10^{-3}\ \Omega$. The loop is initially at rest; then a constant force $F_{ext} = 0.180$ N is applied to the loop to pull it out of the field

   a. What is the acceleration of the loop when v = 3.00 cm>s?
   b. What are the loop's terminal speed and acceleration when the loop is moving at that terminal speed?
   c. What is the acceleration of the loop when it is completely out of the magnetic field?



Scratch work for question 8

Scratch work for question 8

Rubric For Physics 22 Exam 3

Question 1

1 part a

- **+0.5** Write $\Sigma F_r = ma_r$
- **+0.5** $a_r = \frac{v^2}{r}$
- **+1.0** $\vec{F}_B = q\vec{v} \times \vec{B}$
- **+1.0** $R = \frac{mv}{qB}$
- **+1.0** diameter $= 2R$
- **+1.0** calculate diameter
- **-0.5** calculation error
- **-0.5** order of magnitude error

2 part b

- **+1.0** Note that the magnetic force is perpendicular to velocity
- **+1.0** The magnetic force is the direction of acceleration
- **+1.0** Since acceleration is perpendicular to velocity, the speed of the particle is unaffected
- **+0.0** blank b

3 part c

- **+2.0** Calculate a
- **+1.0** Note that acceleration is directed inward
- **+0.0** blank part c
- **-0.5** calculation error
- **-0.5** order of magnitude error

4 part d

- **+2.0** An external net force will have an acceleration, but since the acceleration is perpendicular to the velocity vector, the magnitude to the velocity will not change
- **+0.0** blank part d

Question 2

1 Part A

- +1.0
  $W = \Delta K$
- +1.0
  $W = q\Delta V$
- +1.0
  $\Delta K = \frac{1}{2}mv^2$
- +1.5
  $\frac{q}{m} = \frac{v^2}{2\Delta V}$
- -0.5
  missing factor of 2

2 Part B

- +1.0
  $\Sigma F = m\frac{v^2}{R}$
- +1.0
  $F_B = qvB$
- +1.0
  $v = \frac{q}{m}RB$

3 Part C

- +1.5
  Plug part b into part a
- +1.5
  Solve for $R^2 = \frac{2}{B^2(q/m)}\Delta V$
- +2.0
  Solve for q/m in terms of B and the slope
- +1.0
  caculate q/m
- -0.5
  calc error
- +0.0
  no part c
- -0.5
  order of magnitude error

4 Part D

- +1.5
  Notice that the charge-to-mass ratio matches an alpha particle (helium nucleus) (Or a ${}_2H$ deuteron) (1/2 of a proton)
- +0.75
  note how the q/m compare to other particles (partial credit)

Question 3

1 Part A Draw a sketch

- **+1.5** One line is along $x = y$
- **+1.5** Intercepts along the $y-$ and $x-$axis
- **+1.0** Lines (starting at the intercepts) curve toward the $x = y$ line, but don't cross
- **+0.5** Arrows point away from the origin

2 Part B

- **+2.0** Integrate to get the force on side 1, from $(0, 0)$ to $(0, L)$
- **+0.5** Get the right direction for the force on side 1
- **+2.0** Integrate to get the force on side 2, from $(0, L)$ to (L, L)
- **+0.5** Get the right direction for the force on side 2
- **+2.0** Integrate to get the force on side 3, from (L, L) to $(L, 0)$
- **+0.5** Get the right direction for the force on side 3
- **+1.5** Integrate to get the force on side 4, from $(L, 0)$ to $(0, 0)$ (integral =0)
- **+1.0** Integrate and get a nonzero value for side 4 (incorrect)
- **+0.5** set up an integral (partial credit)
- **-0.5** incorrect bounds of integration
- **-0.5** missing negative sign
- **-0.5** integration error
- **+0.5** attempted to find the force without integration (x1)
- **+1.0** attempted to find the force without integration (x2)
- **+1.5** attempted to find the force without integration (x3)
- **+2.0** attempted to find the force without integration (x4)
- **-1.5** integration error (x3)

3 Part C

- **+2.5** Sum all of the forces
- **-0.5** Didn't have the sum of the forces in the $x-$direction (=0)
- **-0.5** Forgot I term
- **+0.5** set up the sum

Question 4

1 **+1.0**

Divide each wire into 3 pieces

2 **+1.5**

Note that the straight sections of each wire don't generate any magnetic field at P

3 **+1.5**

Apply the Biot-Savrt law to the semicircles $d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l}\times\vec{r}}{r^3}$

4 **+2.0**

$d\vec{l} \times \vec{r} = Rdl$ (r is constant and the radius, $d\vec{l}$ and $\vec{r}$ are always perpendicular)

5 **+1.0**

Note that all terms besides dl are constant in the integral

6 **+1.0**

$\int dl = \pi R$ (length of wire in a semicircle)

7 **+2.0**

$B = -\frac{\mu_0 I_1}{4R}$ (into the page) for the top half

8 **+2.0**

$B = \frac{\mu_0 I_2}{4R}$ (out of the page) for the bottom half

9 **+1.0**

Note that $B = 0$ when $I_1 = I_2$

0 **+0.0**

Blank

+0.0

didn't note the directions of the magnetic fields

-1.0

off by a factor of 2

Question 5

1 Part A

+2.0
correct

+0.5
set up integral

-0.1
missing term

2 Part B

+2.0
correct

+0.5
set up integral

3 Part C

+2.0
correct

-0.25
incorrect sign

+1.5
incorrect geometry for I_{enc}

+0.5
set up integral

-0.1
missing term

Select mar

4 Part D

+2.0
correct

+1.0
performed integral but didn't realize that $I_{enc} = 0$

+0.5
set up integral

Question 6

1 Part A

+4.0
Found the number of turns per length

+2.0
Used the magnetic field of a toroid formula

-1.0
Incorrect L

2 Part B

+2.0
Found the total number of turns

+1.0
Found the length of wire per turn

+2.0
Found the total length of wire

-1.0
extra term

-0.5
missing factor of 2

+0.0
forgot to convert turns per length to total turns

Question 7

1 Part A

+2.0
Calculate the magnitude of the induced current

+1.0
The induced current is clockwise

2 Part B

+3.0
The flux is not changing so the emf and I are zero

3 Part C

+2.0
Calculate the magnitude of the induced current

+1.0
The induced current is counterclockwise

4 Part D Sketch

+1.0
Have the first region be constant (either positive or negative, depending on convention) while the loop enters the magnetic field

+1.0
Have the second region be zero while the loop is in the field

+1.0
Have the third region be constant (opposite to the first region) while the loop exits the magnetic field

+0.5
have the second region be constant but not zero

+0.5
have the third region be constant but not flipped sign from first region

5 +0.0
Blank

6 -0.5
extra term

7 -0.5
incorrect L for the loop

Question 8

1 Set up

- +1.0 $\mathcal{E} = vBL$
- +1.0 $F_B = ILB$
- +1.0 $\mathcal{E} = IR$

2 Part A

- +1.5 Combine the expressions to get $F_B = v(BL)^2/R$
- +1.0 Newton's 2nd Law: $F_{ext} - F_B = ma$
- +1.5 Solve for a
- +1.0 Calculate a
- +0.5 Set up Newton's 2nd Law without the F_{ext}
- -0.25 calc error
- -0.75 algebra error

3 Part B

- +1.0 at terminal speed $F_{ext} = F_B$ $(a = 0)$
- +1.0 Solve for the terminal speed
- +1.0 Calculate the terminal speed
- -0.25 calc error
- +1.0 attempted to find terminal speed

4 Part C

- +1.0 Outside the loop, $F_B = 0$
- +2.0 Calculate $a = F_{ext}/m$
- -0.25 calc error

2025.1 Spring Phys Sci FT Evaluation_Kevin Roberts

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