Physics Integrative Exercise 2021-2022

1 Overview

The Physics Integrative Exercise, a.k.a. Comps, is the culmination of your hard work at Carleton. You graduating seniors will leave Carleton with a working knowledge of a broad range of sub-fields within physics as well as an understanding of how to study, investigate, research, learn, and communicate that knowledge. To demonstrate this, you will learn about a topic of your choosing, write a paper on it, and make a presentation on it. This document is your reference manual for this process. It describes all required elements of your project and the deadlines associated with them.

Your first assignment for comps is to choose three possible topics within (or related to) physics, that will meet the College and Department requirements for the integrative exercise. You will then focus on one of them and research it using textbooks, the existing literature, and broader resources. You will then report on what you have learned with (i) a **50-minute presentation**, and (ii) with a paper on your topic with **7500 word maximum.** Your audience for both these products is your fellow physics seniors. You are welcome to invite a general audience for your talk, but we expect you to aim the talk at a level appropriate for your fellow compsing physics majors.

In addition to those two major products mentioned above, there are **three** other tasks you must complete. **(i)** You will act as a primary peer advisor for another student. This means that you will read both the first and second written papers, and will meet with them and their faculty advisor twice during their comps process for a detailed conversation. You are also encouraged to help them with their talk preparation based on your pre-talk interactions with them, and to attend their talks. **(ii)** You will act as a secondary peer advisor for another student, which means that you will provide feedback on their talk, and their second written paper, and will meet with them and their faculty advisor twice during their comps. (**iii)** Finally, you must attend at least **six** of your peers' talks, typically including the two for which you are a peer advisor as above. Specific details of each of these components are in Section §2, and their deadlines are summarized on the **final page**. It is crucial that you meet all deadlines as you move through the comps process. Once the final schedule is set, it is extremely difficult to make changes.

You must successfully complete all components of the comps process to pass comps. Your grade will be based on evaluations of your talk, your paper, and your participation in comps overall (including meeting deadlines). You have four primary points of contact to whom you should address questions and concerns, during the process. These are the departmental comps czar (Arjendu Pattanayak this year), Trenne Fields, who will handle scheduling and all your submissions, and your primary and secondary faculty comps advisors (who will be assigned to you the week of **Nov 8th**).

While we expect that you will successfully complete your comps project, it is entirely possible to fail comps because of poor performance on any of the required components including missing crucial deadlines. See Section §3.6 for details.

Pandemic statement: Although we hope to proceed within the spirit of the procedures outlined in this document, an updated version may be distributed at a later date that adjusts procedures to better align with various pandemic-related conditions, or those made necessary by similar factors beyond our control.

2 Assignments

2.1 Fall Assignments: Choosing a Topic and Meeting With Your Advisor

The first step is selecting a good topic. It is very important that you should be interested in the topic. Comps requires a significant amount of work on your part, and you will have more motivation if you are driven by your own interests. Second, a good topic is narrow enough that you can address it with adequate depth, but also allows for the broad inclusion of ideas across physics (e.g. E&M, quantum mechanics, thermodynamics, classical mechanics, optics, etc.). Think about this balance when considering potential topics. If your topic is too narrow, it will likely not be integrative. If your topic is too broad, you will likely not be able to get deep enough within the length and time constraints of the paper and talk. To get a feel for this balance and to see what people have done in the past, you will be asked to review the final papers of several previous students. You might also share your ideas with faculty members for their comments on whether the topic has the potential to be sufficiently integrative. A good rule of thumb is that it should have material at the level of a 300-level class and make reference to material found in more than one 200 and 300 level class.

Current areas of physics research, physics applied to outside or everyday things, historical aspects of physics, and physics applied to societal issues are all areas where people have drawn ideas for topics. If you are having trouble finding a focus for an idea, think of asking a question that your comps will answer. For example, 'What role do phonons play in superconductivity?' As you consider topics, discuss your ideas with at least two faculty members.

There are three assignments during Fall Term. The first, due **Friday, October 15th,** is a list of a minimum of three topics which you are considering. Even if you have a topic you have decided upon, you must submit a minimum of three topics. For each topic, state why you would like to investigate this topic and any questions you would like to answer related to this topic.

The second, due **Friday, October 29th**, has two parts, (a) and (b); note that (a) itself asks you to do 4 separate things.

Part (a): Look over at least two past comps papers from the list provided here `https://docs.google.com/spreadsheets/d/1sU52jEwle3hudN0xtaHwGfpY_9jGOR47wLuMfo9za1U/edit?usp=sharing`. For each paper: (1) indicate which paper you read, (2) make a list of the areas of physics with which the paper engages (E&M, particle physics, etc.), (3) for each area of physics you list, indicate whether you feel this material has been addressed at the 100, 200, or 300 level. (4) Find one example in which one of the papers makes use of material that you saw in your courses, then builds on it, going beyond what you have seen. State the area of physics, what class you saw it in, and briefly (a few sentences) say which parts you'd seen and which were new. As your response to part (a) of this assignment, you should submit a page of short answers and bullet-ed lists that address the questions above. This exercise is aimed at helping you get a better feel for breadth and depth in comps.

Part (b): Write a one-page proposal for the specific topic you would like to focus on for your comps. The proposal should explain why you think this topic is interesting, how it is integrative (i.e., what areas of physics it touches on), and list specific resources that you have identified. List 1-2 questions that you would like your comps to answer. See §3.3 for details on preferences that you can request at these times.

The third, to be done by **November 19th** (the last day of classes), is to meet with your advisor to discuss your project and plans. Before this meeting, consult `https://www.carleton.edu/writing/plagiarism/` to review Carleton's Academic Integrity policy. Be sure you understand what plagiarism is and how to correctly cite others' work. This meeting with your advisor would be a good time to address any questions you may have about academic integrity in this context and any other questions you may have about the comps process, comps timing, appropriate resources, etc.

2.2 Main Paper

The main text of the paper is to be no more than 7500 words. You must include a word count when you submit *each version* of your paper. The word count does not include captions, footnotes, appendices, the bibliography and similar items. While there is no stated minimum length, versions that fall significantly short of the 7500 word target typically do not contain passable breadth and depth. All appendices together must be five pages or less. The form of the paper should follow the guidelines on the "Style Manual" portion of the comps website,[1] and the file should be named as specified in this footnote.[2] All versions of the paper that you submit *at each stage* should be in "publication" form, that is complete, formatted properly, and free of typos and grammatical mistakes. All versions are expected to be in PDF format and all deadlines are at 5PM on the day indicated.

The first version should be electronically submitted to Trenne Fields **and all** advisors (primary and secondary faculty advisors, and primary peer advisor) in **PDF format**[2] **three weeks before the talk**. It should be complete and polished. First versions that consist of fewer than 5000-6000 words of thoughtful material typically lack the content and/or depth necessary to prepare a good talk, and depending on the issues, may fail immediately. You are required to include the first version checklist (available on the comps website[1]) when you submit your paper. Your paper will not be accepted unless you have completed all items on the checklist. Your faculty primary advisor and primary paper peer advisor will read the first version of your paper. You should contact them within **3** days of submitting your paper for a feedback meeting to occur within **10** days of your first version due date. You will also discuss plans for your talk with your advisors during or shortly after this meeting.

Two weeks after your talk, your **second version** of the paper and the associated checklist are due

[1] `https://apps.carleton.edu/curricular/physics/major/comps/`

[2] Name the file <First Last> First Version Comps, <First Last> Second Version Comps, or <First Last> Abstract, <First Last> Final Comps (e.g., Trenne Fields Final Comps).

in **PDF format**[2] to Trenne Fields **and**all advisors (primary and secondary faculty advisors, and primary and secondary peer advisors). This version should respond to the feedback from your advisors and be quite polished. A week after submitting your second version you will meet with your primary faculty advisor and both peer advisors together to receive feedback. You may be asked to also meet with your secondary faculty advisor at this point for additional input.

The **third and final version** of your paper is due **five week**s after your talk.[2] Email this version in **PDF format**[2] to Trenne Fields **and your primary and secondary faculty advisors only**. This version should be of "archival" quality. It will be evaluated by your faculty advisors, and bound into a volume for the department and you will electronically archive it at the library.[3] The final version must include an annotated bibliography. This is invaluable as a tool for us to understand how you used your sources, as well as a way for future readers to retrace your intellectual steps. This is not just an appendage, but an honest summary of how useful you found the various sources – something 'normal' bibliographies sadly do not do very well. Resources on annotated bibliographies are provided in the footnotes.[4] [5]

It is crucial that you honor the deadlines for your paper. This is necessary to give your readers adequate time to provide thoughtful feedback as well as keeping you on track to finish on schedule. If you submit any version of your paper late, there will negatively impact your grade for comps. This will mean not receiving distinction in comps or potentially even failing comps, leading to your needing to complete comps out of residence (see §3.6 for more details).

2.3 Primary peer review

Everyone participating in comps will be the primary peer reviewer for one other student, responding to the **first and second versions of their paper**. In your role as peer advisor, read and comment carefully and thoughtfully. Come prepared to provide constructive feedback to the author **in meetings along with their primary faculty advisor**. The peer review process is a critical part of comps and you are expected to engage with it thoroughly and thoughtfully. Your performance on this section may influence your grade, particularly in consideration for distinction. You will also be a secondary peer reviewer for **a second peer** as we now describe (see §2.4 for the latter.)

2.4 Secondary peer review

Apart from your role as a primary reviewer above, you will will be assigned to be **secondary peer reviewer** for a another person. In this role, you are expected to **attend the first meeting after the talk** with notes providing careful, thoughtful, sensitive, constructive commentary based on your experience as part of the talk audience. (This means that you must be a synchronous audience member for the entirety of the talks you are reviewing).

The goal is communicate again what was clear, what was confusing, what could be deeper, what was too technical, and in general what you believe could be improved in the paper version and how, etc. Peer feedback is used to judge the efficacy of the talk for the speaker's peers. Praise or complaints about the presentation without detailed thought is not helpful. The thoughtfulness of your feedback on the talk will be part of the consideration for your grade including the possibility of distinction. You will **also** respond with **detailed feedback to the second version** of this person's paper, which you will communicate at the designated meeting with their primary faculty advisor and their primary peer advisor.

2.5 Publicity Abstract

You must submit an abstract, maximum word count of ~ 250, to Trenne Fields a week before your talk. The abstract will be published in Radiations, posted on the Comps bulletin board outside the main department office, and sent to all Comps students.

[3] Visit `https://apps.carleton.edu/campus/library/help/libe_help/digital_comps/` for details on digital archiving.

[4] For a concise description of an annotated bibliography, visit `https://guides.library.cornell.edu/annotatedbibliography`.

[5] For examples of different types of annotated bibliographies, visit `https://writing.wisc.edu/handbook/assignments/annotatedbibliography/`.

2.6 The talk and immediately after

The most public portion of comps is an oral presentation in the form of a 50-minute talk (with an extra 10 minutes for questions) that serves to anchor the comps process. Your talk should have a logical narrative that your audience can follow. It is your job as a speaker to keep them engaged in this narrative while clearly communicating content. The talk should be aimed at the level of your fellow senior physics majors who have a solid foundation in physics (i.e., the same core courses as you), but are not experts in your exact topic. Others in the audience should be able to follow some of your talk, but it is OK if they do not absorb all of the physics.

Your goal during the talk is to clearly and effectively communicate what you have learned about your topic. This requires careful planning and **practice**. A common mistake is to cover too much material. Your talk will likely cover less than your paper. Carefully plan your use of presentation slides, whiteboards, demos, and/or visual aids. You should practice giving your talk to a sympathetic yet critical audience, in particular including your talk peer advisors. This will give you a sense of the length, clarity, pacing and other elements of your talk. Bruce Duffy is available to help you with the technical audiovisual aspects of projecting your talk from a computer, etc.

While the goal is a 50 minute talk, a talk in the range of 30-50 minutes can pass. We have found that a student preparing a 50-minute talk is able to significantly improve their paper after the talk. It is also an excellent opportunity to practice honing a time-limited presentation. Finally, only talks that are within a few minutes of 50 minutes will be considered for distinction. Any talk that is shorter than 30 minutes will earn an automatic failing grade.

After the talk, regardless of length, there will be time for audience questions. Following this, you will stay with your advisors and possibly other faculty to answer some questions in private about your comps. During this time they will consider more specific details about your presentation, and the process provides feedback that informs your second version of your paper and a chance for a deeper discussion depending on the time remaining.

Assuming in-person talks and food-service are possible, the department will provide modest snacks for your talk, and your primary faculty advisor will be responsible for bringing the snacks and hot drinks to your talk.

You should reach out to your primary advisor and peer reviewers immediately after your talk to arrange a time to discuss reactions to your talk and to consider future versions of your paper. This meeting should take place within three working days of your talk.

2.7 Talk Attendance

You are required to attend at least **six** talks – the two for which you are either a primary or secondary peer reviewer count towards these – and four others. These talks can be in any section. If pandemic conditions permit, attendance sheets will be passed around during each talk and the onus is on you to sign the attendance sheets so we can record that you attended the required number of talks. *If you do not sign the attendance sheet, you will not receive credit for attending the talk.* You cannot pass comps if you do not attend the required number of talks. It is a violation of academic honesty to sign into a talk for which you did not attend the entire talk, or to have another student sign in for you if you do not attend. If dictated by pandemic conditions, attendance may be tracked using some other mechanism.

3 Logistics

3.1 Comps sections and faculty advisors

This year we will operate four comps sections. Specifically, based on indicated preferences (see below) you will be assigned to a comps section (Mon 1a, Wed 1a, Wed 6a, or Fri 6a meeting time) consisting of two faculty (A,B) and six other students. Four of the seven students in the group will have Faculty A as primary advisor and Faculty member B as the secondary advisor, and the other way around for the other three. The students who will serve as your paper peer advisors and your talk peer advisor (as well as for whom you will act in that role) will all be from this comps group.

Your primary advisor is your main point of contact throughout the process. In particular they will read your first and second versions of your paper and provide feedback. Your secondary faculty advisor will attend your talk and provide feedback through your primary faculty advisor on your talk. Both your

primary advisor and secondary advisor will read your final version and evaluate it in consultation with the rest of the faculty.

In general, your primary advisor will be available for advice throughout the process, and you can consult them for advice on things such as preparing an outline and planning your talk among other things. After your talk, your second advisor will likewise be up to speed and available at all further stages. If there are significant concerns related to the content of your second version, your primary advisor may suggest a meeting with your secondary advisor in addition to the meeting you will have with your primary and peer advisors.

Note that your advisors can provide guidance on issues such as breadth, depth, clarity, organization, etc, but are not expected to have any special expertise related to your topic. They, or others in the department, may offer to help you think through some physics, but they are not responsible for teaching you the topic. In fact, *you* will become the local expert on your topic and will teach it (though your paper and talk) to others.

3.2 Sections and presentation slots

Comps talks will take place at Monday 1a, Wednesday 1a, Wednesday 6a, and Fridays at 6a during weeks four through ten of Winter Term (subject to change as the Winter Term schedule takes shape) and the first two weeks of Spring Term. You will be assigned to a comps section, but you are encouraged to attend talks in any of the other sections in addition to your own.

3.3 Indicating Your Preferences

You have the opportunity to indicate constraints and preferences about sections and a talk date. You must indicate these in one of the assignments submitted during Fall Term, preferably when the first assignment due October 15th. If you are unable to participate in either a 1A or 6A sections you must explicitly explain why (e.g. athletics during 6A or you are taking a 1A course during Winter Term). The earliest possible talk date, January 24th, would lead to the first paper being due the first day of classes Winter Term, January 5th.

By the week of November 8th you will be assigned a date for your talk and your advisors. We will do our best to accommodate constraints and preferences as possible.

3.4 Registration and Credits

Comps is a six credit class. You may either take all six credits during Winter Term, three credits during Winter and three credits during Spring, or all six credits during Spring. The distribution of credits over Spring and Winter Term should approximately reflect when most of the work is done. For example, if the final version of your paper is due during Winter Term you should take all six credits during Winter Term. You should register for your credits after the presentation schedule has been announced.

3.5 Evaluation

You will be assigned one of three final grades: pass with distinction, pass, or fail. You will be evaluated on the following:

- Your ability to construct a cohesive narrative in your talk and final paper, which is integrative and presented at an appropriate level and length.
- Your command and understanding of your topic.
- Your general written and oral communication skills.
- Your adherence to deadlines.
- Your participation in the comps process as a whole. This includes peer review for the written papers as well as for the talk, talk attendance, and asking thoughtful questions at talks.

To receive a passing grade both the talk and final paper must meet the minimum standards for passing and you must complete all the other comps activities with reasonable quality and without hassle. To be considered for distinction: 1) Your talk must be 50 minutes long (not including the 10-minute question

period), 2) both your talk and paper must be evaluated as outstanding (see attached rubrics), and 3) you must complete all the other comps activities with reasonable quality and without hassle. You will be notified within a week of submitting your final version whether you passed comps. The determination of which comps earn distinction will not be made until after the final version of all comps have been submitted.

3.6 Failure and Subsequent Options

It is possible to fail comps at any stage, for example, an insufficiently complete first version can result in a fail. Anyone who fails the comps process sketched above may pass it over the summer or in subsequent years by one of two options. Option 1 is completing the remaining portions of comps from the fail point on a longer time scale. Depending on the fail condition, this could require starting the comps process from the beginning. Option 2 is taking and performing adequately on the Major Field Test from the Educational Testing Service (ETS). It should be clear that this is not an easy 'exit' option. The test is a cumulative test over all areas of undergraduate physics that will take a substantial amount of studying to pass. More information about the logistics of this test will be provided to you if and as you need it, particularly since the specifics may change from year to year after you leave Carleton. The earliest a student can take this test is over the summer. Thus, both Option 1 and Option 2 will require completing comps out of residence. Therefore you will not complete all the requirements for the Carleton degree before graduation. A student in this situation will technically leave Carleton not having graduated. However, if permitted by the Academic Standing Committee, they might able to 'walk' at graduation (albeit with an asterisk by their name), but can only get their degree after the Department certifies that they have passed one of these two options. Special note for double majors: Double majors are not allowed to complete comps for a second major after their 12th term, so failure would mean failure to earn a physics major.

3.7 Producing and Formatting Written Work

You may use any text processing program that provides a reasonably professional output and that can provide the required PDF format documents for sharing. Many students use the LaTeX package or variants thereof, but we emphasize that its use is not mandatory! For those who wish to use it, we have collected hints and templates useful for physicists in general and also for comps students in particular.[6]

4 Final Comments

Writing a 7500-word paper is not a trivial task and will require significant time and effort to complete. Be sure to allow plenty of time to complete and polish your paper at each step. If writing does not come easily to you, do not hesitate to seek help early in the process. The Writing Center is a great resource and they are eager to help you with all aspects of your paper.

Giving a 50-minute talk is not a trivial task either. You must equivalently make sure you give plenty of time to practice and adjust your talk for length and ease of understanding by your target audience of physics seniors. Please practice with your peers, and reach out to your advisor for feedback early in the process. Don't forget that the Academic Support Center also has support for speech coaching.

You MUST meet all deadlines in this process. The deadlines are designed to provide sufficient time to complete tasks and receive evaluation on that work. If you do not meet the deadlines you may not receive adequate feedback or have time to incorporate that feedback into an acceptable result. If this happens, the quality of your final product will suffer, and, in the worst case, you will fail the standard comps process and will need to pursue one of the two failure options.

In almost all cases, students remember comps as a worthwhile, interesting, and satisfying undertaking. The faculty agree with this and enjoy seeing the successful result of your work, which often goes beyond the specified requirements of the project. We encourage you to give comps your best effort and discover that you are capable of independently becoming the local expert on your topic.

We look forward to supporting your success. Good luck!

[6] `https://wiki.carleton.edu/display/carl/Physics+LaTeX+Workshop`

FALL TERM 2021 DEADLINES

Friday, October 15	First Fall assignment due: a brief description of at least three topics, submitted to Arjendu (arjendu@carleton.edu) via email. Indicate any preferences for time or date of your talk. Let us know if there is a reason you CANNOT work with someone (for example, a no-contact order). (See §2.1 & §3.3.)
Friday, October 29	Second Fall assignment due: (a) your exploration of past comps and (b) a one-page proposal for your specific topic, submitted to Arjendu as a **PDF** email attachment. This is your last chance to indicate preferences. (See §2.1 & §3.3.)
The week of November 8	You will be notified of your primary advisor, enrollment section, and presentation date.
By Friday, November 19	Meet with your advisor to discuss your progress, plan for the project and discuss any questions you have regarding academic integrity.

WINTER and SPRING 2022 TERM DEADLINES

ALL deadlines are at 5PM Central. Use only PDF format for documents

Presentation - 3 weeks	First version of your paper and 1st version checklist to be emailed to Trenne Fields, both faculty advisors, and your peer advisor[3,4] in PDF format. Include the first version checklist. (See §2.2.)
Presentation - 2 weeks	Meet with primary faculty advisor and primary peer advisor for feedback on your 1st version.
Presentation - 1 week	Email general audience abstract to Trenne Fields[3,4]. (See §2.5).
Presentation	Your talk will be between Jan 24th and second week of Spring Term.
Presentation + 3 days	Conference with primary advisor, and secondary peer advisor to discuss oral presentation and your plan going forward.
Presentation + 2 weeks	Second version of your paper and 2nd version checklist to be emailed to Trenne Fields, both faculty advisors, and both peer advisors[3,4]. Include the second version checklist. (See §2.2.)
Presentation + 3 weeks	Meet with primary faculty advisor and both peer advisors for feedback on your second version. In some cases, meet separately with your secondary advisor.
Presentation + 5 weeks	Final version of your paper to be submitted to Trenne Fields and both faculty advisors. (See §2.2.)
Before end of Spring Term	You will receive your final grade for comps. **Digitally archive** your comps at `https://digitalcommons.carleton.edu/cgi/login.cgi?return_to=https%3A%2F%2Fdigitalcommons.carleton.edu%2Fcgi%2Fir_submit.cgi%3Fcontext%3Dcomps&context=comps`, while Trenne will print your paper for binding.

NOTE: Spring Break is not counted in the official comps schedule. If Spring Break falls in your comps schedule, you have a little flexibility in your schedule. Talk to your comps advisor.

Be sure to meet all deadlines.