

Duke Physics/Biophysics Thesis Rubrics

This document provides a rubric for evaluation of Physics and Biophysics senior thesis. It is based heavily on the BioTAP document created for Duke Biology theses by Professor Julie Reynolds (thanks to Julie Reynolds and Jason Dowd for resource materials).

Rubric I: Assessing the writing

Rubric I (items 1-9) assesses the student's ability to communicate clearly about their research to any member of the faculty in the Physics department, including their research supervisor and committee members, and anyone else in the thesis' target audience. It is worth noting that items 1-5 focus on major writing issues (coherence, organization, etc.), whereas items 6-9 focus on more minor writing issues (mostly associated with correctness). For this reason, items 1-5 will be weighted more heavily than items 6-9 in the final evaluation. To provide feedback to students during the drafting process, committee members will use **Worksheets A**, whereas Research Supervisors will use **Worksheet B**.

Although these worksheets provide a basic structure for faculty feedback, additional feedback –whether written, digitally recorded audio, and/or in person – will also help students through the drafting and revision process.

PLEASE NOTE: Best practices in the teaching of writing discourage faculty from extensive line-by-line editing of student writing. Although this practice is commendable in terms of its intent and may improve the current piece of writing, it is extraordinarily time consuming and is less effective than other kinds of feedback in helping students improve their future writing.

1. ***Is the writing appropriate for the target audience?*** Honors theses should address non-specialist readers with an understanding of basic physics—specifically, any faculty member in the physics department regardless of sub-discipline. Students often struggle to realize that while faculty may be experts within their field of research (e.g., particle physics, condensed matter physics, biophysics), they are rarely familiar with the language and conceptual nuances of other highly-specialized fields of study. Students should assume their readers understand basic physics but they cannot assume that readers readily remember all the details of a given topic. Therefore, students should limit their use of jargon, and should explain or define all key terms and concepts that are specific to their sub-field. This item will be assessed using the following standards:

- **No:** The thesis is written with excessive jargon or is greatly lacking in definitions and explanations, making the research inaccessible to non-specialist readers.
- **Somewhat:** The thesis includes some useful definitions or explanations, but some key terms or concepts are still challenging for the non-specialist reader. Non-specialist readers are able to follow the main themes of the thesis, but the writer has not always made this task easy.
- **Yes:** The thesis has sufficient definitions and explanations to make the research accessible and engaging to non-specialist readers.

2. ***Does the thesis make a compelling argument for the significance of the student's research within the context of the current literature?*** The thesis should contain a substantive literature

review that places the student's research within its appropriate scientific context. This literature review should not only describe what is known about the student's topic, but should also identify the specific gaps in knowledge that the student's project intends to address. The student should make an argument for the broader significance of his/her research when addressing these gaps.

This item will be assessed using the following standards:

- **No:** Either the thesis does not present an adequate review of the literature, OR the thesis does not make sufficient connections between the published literature and the student's own research project to explain its significance.
- **Somewhat:** The thesis presents a literature review, but either does not place the student's research within the context of current or past scientific research, or does not explicitly present an argument for the broader significance and/or scientific value of the student's research.
- **Yes:** The thesis reviews the literature, demonstrates how the student's research fills a gap, and presents a compelling argument for the broader significance or scientific value of the student's research.

3. Does the thesis clearly articulate the student's research goals? The student's research statement should include a research question or the goals of the project, and may also include a hypothesis (if applicable) and an overview of the methodological approach. This item will be assessed using the following standards:

- **No:** The student does not explicitly articulate a research question or the goals of the project.
- **Somewhat:** The student articulates a research question or the goals of the project, but at times in an unclear, inconsistent, or disorganized manner.
- **Yes:** The students clearly and explicitly articulates a research question or the goals of the project.

4. Does the thesis skillfully interpret the results? Student should interpret their results within the scientific context constructed in the Introduction (this should be done in relation to a hypothesis, if applicable). Student writers often overlook the fact that scientific data has complexities that often defy a single interpretation. Therefore, we are also assessing the student's ability to acknowledge this complexity, as well as discuss plausible inconsistencies, uncertainties, alternative explanations, counterintuitive evidence, and/or limitations of his/her results.

NOTE: It is not uncommon for students to have inconclusive or incomplete results – this is perfectly acceptable, and students should not try to obfuscate this fact. We do not expect a student to interpret inconclusive or incomplete results *per se*. Instead, in these cases, we expect students to focus their discussion on the limitations of their results. Hence, if the thesis had

inconclusive or incomplete results, please apply the standards outlined in the alternative rubric (4b). Otherwise, this item will be assessed using the standards outlined in 4a:

Rubric 4a (for theses with conclusive and complete results)

- **No:** There is no interpretation of the results (e.g., a simple restatement of the results) or the interpretation is superficial.
- **Somewhat:** The thesis presents a reasonable interpretation of the results, and **mentions** inconsistencies, uncertainties, alternative explanations, counterintuitive evidence, and/or limitations of the results, but does not explain the implications of these potential problems.
- **Yes:** The interpretation of results is insightful, and the thesis **explains** the implications of plausible inconsistencies, uncertainties, alternative explanations, counterintuitive evidence, and/or limitations of the results.

Rubric 4b (for theses with inconclusive or incomplete results)

- **No:** There is little or no attempt to explain the reasons underlying the lack of clear results.
- **Somewhat:** The thesis provides a reasonably thorough explanation of the reasons underlying the lack of clear results, and includes a reasonable attempt at interpreting whatever results were obtained.
- **Yes:** The thesis provides an insightful explanation of the reasons underlying the lack of clear results.

5. *Is there a compelling discussion of the implications of findings?* We expect students to explicitly explain the implications of their research findings within the scientific context constructed in the Introduction. One way students accomplish this is by making the connections between their results and other published results. Another way is by indicating how their projects could lead to future research within their field of inquiry, which could include suggestions for additional experiments and/or alternative approaches. It is appropriate for students to speculate – this is their opportunity to demonstrate understanding of the big picture.

NOTE: Although we *do* expect a discussion of the implications of negative results, this is not appropriate for inconclusive or incomplete results. In these latter two cases, we expect students to focus their discussion on future directions. For theses with inconclusive or incomplete results, please use alternative rubric 5b. Otherwise, this item will be assessed using the standards described in 5a:

Rubric 5a (for theses with conclusive and complete results)

- **No:** The thesis makes little or no attempt to discuss the implications of the findings or does not describe future directions for the project
- **Somewhat:** The thesis makes some attempt to discuss the implications of the findings, but does not explain their significance OR the thesis mentions possible future studies without explaining how they would contribute significant new knowledge to the field.
- **Yes:** The thesis provides a compelling discussion of the implications of the findings, including a thorough consideration of possible future studies.

Rubric 5b (for theses with inconclusive or incomplete results)

- **No:** The thesis makes little or no mention of future directions or alternative approaches for the project.
- **Somewhat:** The thesis provides some discussion of possible future studies or alternative approaches without explaining how they would contribute significant new knowledge to the field.
- **Yes:** The thesis provides a thoughtful and thorough discussion of possible future studies or alternative approaches.

6. *Is the thesis clearly organized?* The thesis should be organized in the standard IMRaD fashion (Introduction, Methods, Results, and Discussion). Within paragraphs, sentences should be cohesive and logically organized. This item will be assessed using the following standards:

- **No:** The thesis does not adhere to the IMRaD organization, or the writing within paragraphs is frequently difficult to follow.
- **Somewhat:** The thesis adheres to the IMRaD organization, and the writing within paragraphs is usually easy to follow.
- **Yes:** The thesis adheres to the IMRaD organization, and writing within paragraphs is easy to follow in almost all cases.

7. *Is the thesis free of writing errors?* The mechanics (spelling, grammar, punctuation) and presentation of the thesis should be correct and professional. This item will be assessed using the following standards:

- **No:** The thesis contains excessive errors or is presented in an unprofessional manner.
- **Somewhat:** The thesis contains some errors.
- **Yes:** The thesis is virtually free of obvious errors.

8. Are the citations presented consistently and professionally throughout the text and in the list of works cited? The citation format should be consistent throughout the thesis, and references should be professionally presented. This item will be assessed using the following standards:

- **No:** The thesis uses inconsistent citation format, is missing citations, or presents the list of works cited in an unprofessional manner.
- **Somewhat:** The thesis uses consistent and appropriate citation format and presents the list of works cited in a professional manner, although there may be some minor inconsistencies or errors.
- **Yes:** The thesis uses consistent and appropriate citation format and presents the list of works cited in a professional manner.

9. Are the tables and figures clear, effective, and informative? Tables and figures should be consecutively numbered, cited in consecutive order, and the captions should be in the appropriate location (above tables, below figures). The thesis should refer explicitly to each table or figure (e.g., "...reveals an upward trend (Figure 1).") and the visual elements of all tables and figures (including photographs) should be clear and easy to read or interpret. The captions should provide a clear description of the table or figure. This item will be assessed using the following standards:

- **No:** Many of the tables or figures are misleading, incorrect, unclear, or inappropriate, or the captions are incomplete or unclear.
- **Somewhat:** In general, the tables, figures and captions are clear and appropriate.
- **Yes:** The tables and figures are exceptionally well constructed, and the captions clearly describe the visual elements.

Rubric II: Assessing the research

Seldom in our professional lives do we have the luxury of having a mentor who knows enough about our research projects to ensure the accuracy of our analyses, and writing a thesis is one of those times. Therefore, Rubric II (items 10-13) assesses the accuracy and completeness of the student's research. This part of the rubric is appropriate only for experts in the student's field of research, such as the student's Research Supervisor. Research Supervisors should use **Worksheet B** to provide feedback to students during the drafting process. Although this worksheet provides a basic structure for faculty feedback,

additional feedback –whether written, digitally recorded audio, and/or in person – will also help students through the drafting and revision process.

PLEASE NOTE: Best practices in the teaching of writing discourage faculty from extensive line-by-line editing of student writing. Although this practice is commendable in terms of its intent and may improve the current piece of writing, it is extraordinarily time consuming and is less effective than other kinds of feedback in helping students improve their future writing.

10. Does the thesis represent the student's significant scientific research? To graduate with honors, students should demonstrate the ability to conduct original/independent/significant research. For the award of High Honors, we are especially interested in identifying those students whose work represents significant scientific innovation or insight. This item will be assessed using the following standards:

- **No:** The thesis represents little more than the student's ability to follow the instructions of a research supervisor (including graduate student/post-doc supervisors). The student made little (if any) significant contribution to the development of the project or the research agenda.
- **Somewhat:** The thesis demonstrates the student's ability to contribute his/her own thoughts and ideas into a significant research project.
- **Yes:** The thesis not only represents the student's original thoughts and ideas, but also demonstrates exceptional innovations, insights, or creativity.

11. Is the literature review accurate and complete? This item will be assessed using the following standards:

- **No:** The literature review is incomplete, missing many salient articles.
- **Somewhat:** Although the literature review may have missed a few relevant articles, the literature review nevertheless makes a strong argument for the relevance of the student's research in the context of the current literature.
- **Yes:** The literature review fully and accurately summarizes the salient literature.

12. Are the methods appropriate, given the student's research question? Often, students will use the methods they are most familiar with rather than the methods that are most appropriate for addressing their research question. *Note: If the student's research focused on testing new methods, then students should not be evaluated on whether or not the methods were effective, but rather on the appropriateness of their approach to testing new methods.* This item will be assessed using the following standards:

- **No:** The methods chosen are ineffective and/or inefficient, given the student's research question.
- **Somewhat:** The methods selected were appropriate, given the student's research question.
- **Yes:** The student demonstrated creativity or innovation in selecting a methodology that would not only address his/her research question, but would also answer that question efficiently or highly effectively.

13. Is the data analysis appropriate, accurate and unbiased? Did the student accurately and appropriately analyze the data? Were the interpretations of the results accurate and unbiased? This item will be assessed using the following standards:

- **No:** The data analysis was inappropriate, inaccurate, or biased.
- **Somewhat:** The data analysis was appropriate, accurate and unbiased.
- **Yes:** The data analysis was not only appropriate, accurate and unbiased, but the approach was also particularly insightful or proposed creative new approaches for future research in this field.

Rubric III: Assessing the presentation

Rubric III is an assessment of the thesis defense presentation. Both committee members and research supervisors will use this rubric in their final evaluation of the thesis project at the time of the defense.

14. Was the defense presentation well organized and complete? For this item, the organizational criteria are similar to those for evaluating the thesis, but relevant to the narrative nature of an oral delivery. This item will be assessed using the following standards:

- **No:** The presentation was disorganized and presented a difficult-to-follow narrative, and failed to cover essential points.
- **Somewhat:** The presentation was well organized and described the complete thesis content with appropriate emphasis and an easy-to-follow narrative.
- **Yes:** The presentation was extremely well organized and effectively described the thesis content by a compelling narrative.

15. Did the student demonstrate full understanding of the research and its context at the defense? We expect students to have full understanding of all aspects of the research project, including background material and scientific context. They should be able to answer most questions asked by the committee. This item will be assessed using the following standards.

- **No:** The student was unable to answer most questions from the committee or demonstrate basic understanding of the research or its context.
- **Somewhat:** The student demonstrated good understanding, at an undergraduate level, of the presented research and its context, and could answer most questions from the committee.
- **Yes:** The student demonstrated superior insight into the research topic and deep knowledge of the research subfield.

16. Was the defense presentation delivered for effective communication? We expect students to be able to deliver a presentation clearly and at the appropriate level for the audience, and to interact with the audience with poise and confidence. This item will be assessed using the following standards:

- **No:** The student did not communicate clearly with the audience. Slides and graphics were unclear for non-experts.
- **Somewhat:** The student communicated clearly and with confidence. Most slides and graphics could be understood easily by a general audience.

- **Yes:** The student communicated with excellent style and effectiveness, and always employed easy-to-understand slides and graphics.

Rubric IV: Standards for awarding Honors and High Honors

Rubric IV is a holistic assessment of the overall quality of a student's thesis. Both committee members and Research Supervisors will use this rubric in their final evaluation of the thesis.

For a thesis to be considered for the award of **Honors**, the student must have demonstrated *proficiency in scientific research*, as demonstrated by:

- An original, independent, and substantive research question,
- Care in data collection and analysis,

and have produced a written thesis that achieves the following:

- Is written to a broad audience of physicists (rather than only specialists in the field of research),
- Situates the research in the appropriate scientific context,
- Explicitly interprets results in relation to the hypothesis,
- Discusses inconsistencies, uncertainties, or limitations of the results, and
- Is coherent, free of errors, and otherwise professionally presented.

For a thesis to be considered for the award of **High Honors**, the thesis must meet all the criteria for the award of Honors. In addition, the student must have demonstrated *an exceptional ability to conduct scientific research*, as demonstrated by:

- Scientific innovation, insight, or creativity, OR
- Exceptional care in data collection or analysis,

AND have produced a thesis that is compelling and well-written. High Honors theses will be posted on the department website

Worksheets

Worksheet A: Feedback from Committee Members

To be completed by student

Student's name _____

Date _____

Draft Number _____

Thesis title _____

Committee Member

To be completed by Committee Member

	No (inadequate)	Somewhat (adequate)	Yes (excellent)
1. Is the writing appropriate for the target audience?			
<i>Comments</i>			
2. Does the thesis make a compelling argument for the significance of the student’s research within the context of the current literature?			
<i>Comments</i>			
3. Does the thesis clearly articulate the student’s research goals?			
<i>Comments</i>			
4. Does the thesis skillfully interpret the results?			
<i>Comments</i>			
5. Is there a compelling discussion of the implications of findings?			
<i>Comments</i>			

	No (inadequate)	Somewhat (adequate)	Yes (excellent)
6. Is the thesis clearly organized?			
<i>Comments</i>			
7. Is the thesis free of writing errors?			
<i>Comments</i>			
8. Are the citations presented consistently and professionally throughout the text and in the list of works cited?			
<i>Comments</i>			
9. Are the tables and figures clear, effective, and informative?			
<i>Comments</i>			

Additional comments from Committee Member:

Worksheet B: Feedback from Research Supervisor

To be completed by student

Student's name _____

Date _____ Draft Number _____

Thesis title _____

Research Supervisor _____

To be completed by Research Supervisor

	No (inadequate)	Somewhat (adequate)	Yes (excellent)
1. Is the writing appropriate for the target audience?			
<i>Comments</i>			
2. Does the thesis make a compelling argument for the significance of the student's research within the context of the current literature?			
<i>Comments</i>			
3. Does the thesis clearly articulate the student's research goals?			
<i>Comments</i>			
4. Does the thesis skillfully interpret the results?			
<i>Comments</i>			
5. Is there a compelling discussion of the implications of findings?			
<i>Comments</i>			
6. Is the thesis clearly organized?			
<i>Comments</i>			
7. Is the thesis free of writing errors?			
<i>Comments</i>			

8. Are the citations presented consistently and professionally throughout the text and in the list of works cited?			
<i>Comments</i>			
9. Are the tables and figures clear, effective, and informative?			
<i>Comments</i>			
10. Does the thesis represent the student's original scientific research?			
<i>Comments</i>			
11. Is the literature review accurate and complete?			
<i>Comments</i>			
12. Are the methods appropriate, given the student's research agenda?			
<i>Comments</i>			
13. Is the data analysis appropriate, accurate and unbiased?			
<i>Comments</i>			

Additional comments from Research Supervisor:

Worksheet C: Student response to feedback

To be completed by student

Student's name _____

Date _____ Draft Number _____

Thesis title _____

To facilitate the evaluation of revised manuscripts, we ask that students provide a concise, point-by-point listing of the significant changes that they made in response to each reviewer's comments. List each major comment you received in this table and identify the reviewer (please number each comment). Then, advise your readers about what changes you made in response to the reviewers' comments (and where these changes were made in the revised manuscript). Alternatively, you may rebut any challenges you consider inappropriate provided that you explain why. Minor comments should not be listed below, but you should attend to them in your revision, as they will undoubtedly improve the quality of your writing.

Summary of readers comment/Reader	Student response	Location in revised thesis
<p><i>Examples:</i> 1. My Committee Member said she didn't see the relevance of the article by Smith and Jones (2002) to my research.</p>	<p><i>I rewrote the introduction to the paragraph in which I reviewed Smith and Jones' research, making it more explicit that this research influenced the choice of methods that are commonly used in this field.</i></p>	<p><i>Literature review (in Introduction)</i></p>
<p>2. My Research Supervisor said he didn't think I needed to provide so many background details in the Introduction.</p>	<p><i>I discussed this with my Committee Member who said that as an outside reader, she appreciated the extended background section. So, I decided to keep all the details I presented in the background section, but to revise it for conciseness.</i></p>	<p><i>Introduction</i></p>

Attach additional sheets as is necessary.

Worksheet D: Final evaluation of thesis and defense by Committee Members

To be completed by student

Student's name _____ Date _____

Thesis title _____

Committee

Member _____

To be completed by Committee Member

	No (inadequate)	Somewhat (adequate)	Yes (excellent)
1. Is the writing appropriate for the target audience?			
2. Does the thesis make a compelling argument for the significance of the student's research within the context of the current literature?			
3. Does the thesis clearly articulate the student's research goals?			
4. Does the thesis skillfully interpret the results?			
5. Is there a compelling discussion of the implications of findings?			
6. Is the thesis clearly organized?			
7. Is the thesis free of writing errors?			
8. Are the citations presented consistently and professionally throughout the text and in the list of works cited?			
9. Are the tables and figures clear, effective, and informative?			
14. Was the defense presentation well organized and complete?			
15. Did the student demonstrate full understanding of the research and its context at the defense?			
16. Was the defense presentation delivered for effective communication?			

I nominate this thesis for:

- _____ **Honors** For a thesis to be considered for the award of **Honors**, the student must have demonstrated *proficiency in scientific research*, as demonstrated by:
- An original, independent, and substantive research question,
 - Care in data collection and analysis,
- and have produced a written thesis that achieves the following:
- Is written to a broad audience of physicists (rather than only specialists in the field of research),
 - Situates the research in the appropriate scientific context,
 - Explicitly interprets results in relation to the hypothesis,
 - Discusses inconsistencies, uncertainties, or limitations of the results, and
 - Is coherent, reasonably free of errors, and otherwise professionally presented.
- _____ **High Honors** For a thesis to be considered for the award of **High Honors**, the thesis must meet all the criteria for the award of Honors. In addition, the student must have demonstrated *an exceptional ability to conduct scientific research*, as demonstrated by:
- Scientific innovation, insight, or creativity, OR
 - Exceptional care in data collection or analysis,
- AND have produced a thesis that is compelling and well-written.
- _____ **Disqualified for Honors** A thesis should not be nominated for honors if it does not meet the standards outlined above.

Worksheet E: Final evaluation of thesis and defense by Research Supervisors

To be completed by student

Student's name _____ Date _____

Thesis title _____

Research Supervisor _____

To be completed by Research Supervisor

	No (inadequate)	Somewhat (adequate)	Yes (excellent)
1. Is the writing appropriate for the target audience?			
2. Does the thesis make a compelling argument for the significance of the student's research within the context of the current literature?			
3. Does the thesis clearly articulate the student's research goals?			
4. Does the thesis skillfully interpret the results?			
5. Is there a compelling discussion of the implications of findings?			
6. Is the thesis clearly organized?			
7. Is the thesis free of writing errors?			
8. Are the citations presented consistently and professionally throughout the text and in the list of works cited?			
9. Are the tables and figures clear, effective, and informative?			
10. Does the thesis represent the student's original scientific research?			
11. Is the literature review accurate and complete?			
12. Are the methods appropriate, given the student's research agenda?			
13. Is the data analysis appropriate, accurate and unbiased?			
14. Was the defense presentation well organized and complete?			
15. Did the student demonstrate full understanding of the research and its context at the defense?			
16. Was the defense presentation delivered for effective communication?			

I nominate this thesis for:

- _____ **Honors** For a thesis to be considered for the award of **Honors**, the student must have demonstrated *proficiency in scientific research*, as demonstrated by:
- An original, independent, and substantive research question,
 - Care in data collection and analysis,
- and have produced a written thesis that achieves the following:
- Is written to a broad audience of physicists (rather than only specialists in the field of research),
 - Situates the research in the appropriate scientific context,
 - Explicitly interprets results in relation to the hypothesis,
 - Discusses inconsistencies, uncertainties, or limitations of the results, and
 - Is coherent, reasonably free of errors, and otherwise professionally presented.
 - A thesis defense demonstrating good understanding of thesis content and context and effective communication skills.
- _____ **High Honors** For a thesis to be considered for the award of **High Honors**, the thesis must meet all the criteria for the award of Honors. In addition, the student must have demonstrated *an exceptional ability to conduct scientific research*, as demonstrated by:
- Scientific innovation, insight, or creativity, OR
 - Exceptional care in data collection or analysis,
- AND have produced a thesis that is compelling and well-written and have defended it proficiently.
- _____ **Disqualified for Honors** A thesis should not be nominated for honors if it does not meet the standards outlined above.