Indiana University of Pennsylvania
WAC
Writing Across the Curriculum

Physics and Physics/ Pre-Engineering

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Summary and Goals

The Department of Chemistry, Biochemistry, and Physics (CBP) was formed from the Chemistry Department and Physics departments. The curriculum for Physics and Pre-Engineering is separate from chemistry and biochemistry. Therefore, this report will detail how writing is used in the courses associated with the Physics and Physics/Pre-Engineering degrees and courses taught by professors with their specialty in those fields. This report will present both the way writing is used in these courses at present and our objectives for enhancing the use of writing on these courses in the future.

At a meeting on October 14, 2025, the IUP Physics and Pre-Engineering faculty in attendance unanimously voted to support the Writing Plan as described below in addition to the WAC Director's recommendations for continuing program facilitation on pages 15 of this document.

Historically, the Department of Physics was standalone. It should be noted that within the past three years, the Department of Chemistry and Physics was merged to create the Madia Department of Chemistry, Biochemistry, and Physics (CBP). While the physics courses are taught in CBPE, the physics program and faculty have an autonomous identity. It is for this reason, amongst others, that the department has more than one writing plan.

Due to the mathematical and quantitative nature of physics, there will be some courses, especially at the upper level, where little writing is necessary. In laboratory courses or lecture courses that include a lab component, writing can be a significant part of the learning experience.

This can range from answering short essay questions on standardized report forms in introductory, non-majors' labs, to composing long, detailed formal reports in upper-level labs designed for majors. This plan documents how we plan to change the way we use writing as a teaching and learning tool, rather than only an assessment.

Most of the writing done by the physics and pre-engineering majors will happen in two courses. PHYS 331 Modern Physics is a course where students write a paper on the history of physics. The second course is PHYS 350 Intermediate Experimental Physics Lab. In this course, students write journal-length reports from the student-centered experiments conducted during the class. Other courses will have short paragraphs or sentences completed in various homework assignments and classroom examinations.

Student writing samples were collected from the 2023-2024 academic year. These samples were from the courses mentioned above, PHYS 331 Modern Physics, as well as PHYS 350 Intermediate Experimental Physics Lab. Analysis of the student writing samples revealed that, while most adhered to the required format and used citations appropriately, there was notable room for improvement in both standard English usage and the ability to express ideas in an appropriate scientific style. Many students did not meet expectations for the clarity and objectivity that are hallmarks of strong scientific writing.

To enhance student communication skills, Writing Across the Curriculum (WAC) goals are proposed for physics programs. These goals include:

1. Integrate writing into lecture courses as an instructional tool ("writing to learn") to help students engage more deeply with course content and develop critical thinking skills; and
2. Set clear expectations in laboratory courses that students will not only present scientific findings but also enhance their English language skills and their ability to write in the concise, precise, and objective style typical of professional scientific communication.

Writing Characteristics in Physics

The basic requirement for writing in physics and engineering is a solid command of written English. Students need to understand that effective communication is crucial in any professional environment, and that writing is key to sharing knowledge, ideas, and discoveries. What makes scientific writing different from other types is its focus on precision, clarity, and objectivity. In physics, writing can take the form of a journal article, grant proposal, or literature review. Regardless of the format, the main goal is for the reader to easily understand the specific details and to assess the content based only on factual evidence.

Many students are not accustomed to communicating with the level of rigor expected in scientific writing. Learning to write with precision, clarity, and objectivity requires discipline, but it represents a critical milestone in the development of any scientist. Mastering scientific writing not only strengthens students' academic performance but also prepares them for success in graduate study, research careers, and professional employment.

Desired writing abilities

Characteristics of academic and professional communication in physics and pre-engineering.

- Involves logical, qualitative, and quantitative descriptions using skillful writing, mathematics, and graphics.
- Includes the presentation of results and a description of those results, along with the uncertainty of the measurements.
- Includes the grounding of conclusions on basic physical principles.
- Involves the use of visual aids (such as posters and slides) to accompany oral presentations.
- Is organized and formatted using accepted styles appropriate for specific audiences (technical writing, academic or industrial, popular writing, etc.).

Requirements for Writing in Physics:

- Integrate physics concepts, mathematical equations, and technical graphics seamlessly into their writing.
- Clearly define physics concepts, and their range of validity or uncertainty, and use them consistently in an argument.
- Composing solutions to problems that support a logical process with appropriate mathematics, prose, diagrams, and/or graphs/tables.
- During a laboratory experience, maintain a logbook of research activities, including figures, data tables, graphs, calculations, and explanations of ongoing work.
- Generate reports about experiments in a range of accepted styles appropriate to the audience and situation.
- Demonstrate an ability to communicate uncertainty in scientific results by describing the appropriate statistics.
- Use tools for technical writing, including typesetting of mathematical symbols and equations, as well as using software for analyzing data and generating technical graphics.
- Present results in appropriate formats, including poster presentations and oral presentations (with appropriate visual aids).
- Cite sources in the American Physical Society (APS) or other professional journal styles.
- Conform to standard Academic American English.

After examining the characteristics and requirements for writing in physics, we have arrived at the following criteria to assess our students' writing.

ORGANIZATION: The report is clearly organized. The narrative contains all the necessary topics for the assignment.

- WRITING: The writing is clear, concise, and to the point. The student writes with proper sentences and uses good grammar.
- BACKGROUND & THEORY: The background of the experiment is clearly explained. The equations are supported with clear, descriptive language.

- PROCEDURE & DATA: The procedure was clearly presented. The figures supported by the narrative.
- ANALYSIS: The report clearly explains how the results are obtained from the data. The error analysis is clearly presented and follows from the procedure and data sections
- CONCLUSION: The results are well explained within the context of the background of the experiment. Deficiencies in procedure or analysis are adequately presented.

Integration of Writing into Undergraduate Curriculum

Three different types of physics courses will utilize different types of writing assignments - Lecture Courses, Laboratory courses, and Service Courses. Lecture courses that can have 15 to 100 students are standalone courses. There would be less writing in a lecture course when compared to a laboratory course. The courses would have students write short paragraphs or essays. These essays would have the student explain or elaborate on a certain physics concept. While some of these might be administered on homework sets, it is more likely to see these writing samples during a summative assessment in the lecture.

Physics is a mathematical and analytical discipline. There are some courses where writing is not the primary emphasis. However, others will make a strong commitment to writing. In the introductory lab courses, students write page-long reports describing the conclusion of their experiment.

The course Student Learning Outcomes for ENGL 202 are as follows:

1. Develop a **research-based inquiry** project(s) in a variety of genres; prepare **rhetorically effective** projects that demonstrate understanding of audience, genre, purpose, and context.
2. Produce and engage in effective multi-modal communication for academic, professional, and general audiences using information and digital literacies, adapting to an evolving technology landscape.
3. Demonstrate **critical reading and information fluency** by evaluating a diverse range of sources for credibility and rhetorical context.
4. **Synthesize** multiple perspectives (including one's own) to engage with an academic and/or public conversation; apply a **standard citation** style(s) and conventions that acknowledge others' **intellectual property**.
5. Practice **metacognition** by reflecting on one's own work, giving feedback to others, and using feedback from others to **revise.**

Physics and Physics/Pre-Engineering majors will not be required to take ENGL 202 (Composition II). Instead, they fulfill the objectives of ENGL 202 through written assignments embedded in their upper-level physics courses. These courses, which involve substantial research and experimentation, enable students to meet Student Learning Outcomes (SLOs) 1 through 4 by designing and executing experiments. As part of this process, students consult peer-reviewed physics journals, apply their findings to guide experimental procedures, and produce a formal written report that is assessed for both scientific content and communication skills. In the case of

SLO 5, effective oral communication is achieved through student presentations. After each experiment, students deliver brief research talks, during which their peers offer comments and constructive feedback. This format encourages students to reflect on their work, engage in critical thinking, and articulate their scientific reasoning, thereby reinforcing the importance of clear and thoughtful communication in both written and spoken forms.

Process Used to Create This Writing Plan

The current department of Chemistry, Biochemistry, and Physics is a combination of the previous Physics department and Chemistry department. There were different departments offering different degrees; therefore, there is a separate writing plan for chemistry, one for environmental engineering, and one for physics. The new writing across the curriculum planned was implemented at the same time the two departments were merging. There were many issues to contend with; therefore, the immediate start of the WAC plan was not possible. Now that the new department has been in existence for at least three years, the physics faculty has been able to compile this plan.

This plan was developed in consultation with the chemistry and biochemistry faculty in the Department of Chemistry, Biochemistry, Physics, and Engineering over the course of several years. The faculty took part in training on writing across the curriculum using the online course designed by the WAC director. The departmental ad hoc WAC committee consists of three faculty members (Fair, See, and Sobolewski).

This proposal was developed using several channels of information and feedback. This included the following:

- Discussions with faculty, both before this proposal was developed and at various points during the drafting of this document.
- Information collected for the Course Outcomes and Activities Chart in Section 5.
- Analysis of the initial writing samples collected from introductory physics courses as well as intermediate laboratory reports
- Examples of similar writing proposals and discussions of writing in science, both internal (examples from Biology and Psychology) and external (U. of Minnesota, U. of North Carolina)

The final writing plan was compiled by Dr. Sobolewski with consultation from other physics faculty as well as their writing plan submitted for the chemistry program and the mathematics program.

Course Outcomes and Activities Chart

Course	Expected Writing Outcomes	Writing to Learn Activities	Professional or Academic Genres
PHYS 100 Prelude to physics	Clearly define physics concepts, and their range of validity or uncertainty, and use them consistently in an argument.	Short class summaries of topics presented that week	*(some entries are intentionally blank)*
PHYS 101 Energy and our Environment	apply essential concepts of physics to issues in society as well as the impact on the environment.	write short reviews of journal articles concerning the impact of energy on the environment	Students will write a final paper judging the impact of various energy sources on society as well as the environment
PHYS 105 Physics of light and sound	apply essential concepts of physics to issues related to music and art	write short class summaries on how physics is used in both music and art.	Students will write a final paper describing the physics of an instrument of their choice.
PHYS 111 General Physics I	Clearly define physics concepts and pose solutions to problems	Write short homework summaries on the physics solution to a problem	
PHYS 112 General Physics II	Clearly define physics concepts and pose solutions to problems	Write short homework summaries on the physics solution to a problem	
PHYS 121 General Physics I Lab	Use of measurement equipment to collect data and report results	Lab reports	lab reports requiring analysis of data and text answers to comprehension questions
PHYS 122 General Physics II Lab	Use of measurement equipment to collect data and report results	Lab reports	lab reports requiring analysis of data and text answers to comprehension

			questions
PHYS 131 Physics with Calculus I	Clearly define physics concepts and pose solutions to problems	Write short homework summaries on the physics solution to a problem	
PHYS 132 Physics with Calculus II	Clearly define physics concepts and pose solutions to problems	Write short homework summaries on the physics solution to a problem	
PHYS 141 Physics with Calculus I Lab	Use of measurement equipment to collect data and report results	Each student needs to submit lab reports written in MS Word	lab reports requiring analysis of data and text answers to comprehension questions
PHYS 142 Physics with Calculus II Lab	Use of measurement equipment to collect data and report results	Each student needs to submit lab reports written in MS Word	lab reports requiring analysis of data and text answers to comprehension questions
PHYS 151 Physics for Life Science	Clearly define physics concepts and pose solutions to problems	Write short homework summaries on the physics solution to a problem	
PHYS 161 Medical Physics Lab	Use of measurement equipment to collect data and report results	Lab reports	lab reports requiring analysis of data and text answers to comprehension questions
PHYS 231 Electronics	Use of measurement equipment to collect data and report results	Lab reports	lab reports requiring analysis of data and text answers to comprehension questions
PHYS 260 Intro to Nanoscience	Clearly define physics concepts and pose solutions to problems		
PHYS 321 Computational Physics			
PHYS 331 Modern Physics	Relate the physics concepts to the history of science; when were the major ideas		Two essays, 2500 words each, on the history of Physics

	developed for contextual reference		from Galileo to 1900. The next on nuclear physics, high energy physics, and solid-state physics.
PHYS 342 Thermal & Statistical Physics			
PHYS 345 Optics	Use mathematics to analyze, model, and solve problems in Optics.	Each student writes a project report (4000-5000 words), and a PowerPoint presentation related to a specific area of new technology and development in Optics	
PHYS 350 Intermediate Experimental Physics			students write significant lab reports in this style of a physics journal
PHYS 355 Computer Interfacing			
PHYS 401 Theoretical Physics	Use mathematics to analyze, model, and solve physics problem		
PHYS 441 Classical Mechanics	Use mathematics to analyze, model, and solve problems in mechanics		
PHYS 451 Electricity and Magnetism	Use mathematics to analyze, model, and solve problems in electricity and magnetism		
PHYS 461 Quantum Mechanics I			
PHYS 472 Nuclear Physics			
SCI 101 Fundamentals of Physics	demonstrate understanding of basic physics concepts and how those concepts could be communicated to elementary-age students	After completing each experiment, students provide short answers to several questions	At several points in the semester, students write a reflection on ideas for lessons

		related to the topic of the lab. There are 12 experiments each semester.	or activities based on recent course topics that they could perform with the elementary- age students they will teach once certified.
SCI 105 Physical Science Lecture	apply essential concepts of physics to issues in society		Students work in groups on topics related to physics in the news
SCI 113 Physics in Science Fiction			
SCI 115 Physical Science Lab	demonstrate understanding of essential concepts in introductory physics.	After completing each experiment, students provide short answers to several questions related to the topic of the lab. There are 12 experiments each semester.	

Assessing physics writing can be a challenging task, the following are some critical issues:

1. Accuracy of Content: Check whether the writing accurately reflects the concepts and principles of physics. Verify that the facts and equations used are correct and relevant to the topic.
2. Clarity and Precision: Evaluate the clarity and precision of the writing. Look for clear and concise explanations of physics concepts and avoid ambiguous or confusing language.
3. Evidence and Examples: Assess the use of evidence and examples to support the physics arguments. Check whether the evidence is relevant, reliable, and sufficient to support the results.
4. Graphs and Diagrams: Check the use of graphs and diagrams in the writing. Evaluate whether they are clear, accurate, and relevant to the topic. Ensure that the axis labels, units, and scales are correctly labeled.

5. Formatting and Style: Evaluate the formatting and style of the writing. Ensure that the writing follows the conventions of physics writing and is presented in a professional and organized manner.
6. Problem Solving and Analysis: Evaluate the ability of the writer to solve physics problems and analyze data. Check whether the writer can apply physics concepts to solve problems and analyze data accurately.
7. Feedback and Revision: Provide constructive feedback and suggestions for improvement. Encourage the writer to revise and edit their work based on your feedback.

Overall, assessing physics writing requires a combination of scientific knowledge and critical thinking skills. Providing specific and actionable feedback can help the writer improve their skills and produce better physics writing in the future.

Assessment

Protocol:

Writing samples from PHYS 350 Intermediate Experimental Physics will be used to assess the students' writing. Each student writing assignment will be evaluated using the established rubric, and individual scores will be recorded. The average score of all student assignments will be calculated to assess overall program performance. If the average score is 20 or higher, the current instructional approach will be maintained. However, if the average falls below 20, we will conduct detailed analysis to identify possible causes. Key questions will include: *Was there a specific assignment that significantly lowered the average? Was the sample size large enough to be representative?*
If the low average accurately reflects the students' writing abilities, we will consider appropriate curricular modifications. This may include incorporating targeted instruction on scientific writing, such as a dedicated module or instructional support to strengthen students' communication skills.

The writing samples and grading rubrics below will be used by the course instructor to assign a letter grade to the assignment. At the end of each semester, copies of the student's writing samples will be given to a member of the Writing Across the Curriculum Committee (At this time, most likely Dr. Sobolewski) to assess separately according to the WAC rubric.

Grading Rubric – LAB REPORTS

The organization of the report should follow the format from the syllabus. Aim for about 1500 words.
The procedure section should include a diagram of the apparatus supported by the narrative. The presentation of the data should be concise, flow clearly from the procedure and use tables when possible. The analysis should describe clearly how the results are obtained from data and include an error analysis.

Audience: Assume that you are writing for a peer who is unfamiliar with the experiment and is reading the report with the intention of repeating the experiment or doing a similar experiment or analysis.

CRITERIA	EXEMPLARY 80 – 100 %	COMPETENT 60 – 79 %	BEGINNING 0 - 59 %
ORGANIZATION: Is the report clearly organized, and does the narrative contain all of the necessary topics of the assignment? 0 - 10 points	Report fully meets these parameters. Well-organized, good grasp of the material, explains the material well, and shows a good knowledge of the audience.	Report meets parameters. The presentation may be lacking in some technical aspects of the material presented. The report does not flow well in certain places	Does not meet parameters. Lacking in numerous technical aspects of the material presented. The report does not flow well in numerous places.
WRITING: Is the writing clear, concise and to-the-point? Does the student write with proper sentences and use good grammar? 0 - 20 points	Report fully meets these parameters.	Report meets parameters. Presentation may not flow well in certain places. Transition statements may be lacking or inadequate.	Does not meet parameters. Presentation breaks down in numerous important areas of description.
BACKGROUND & THEORY: Is the background of the experiment clearly explained? Are equations supported with clear, descriptive language? 0 - 20 points	Report fully meets these parameters. Freshman-level equations derived. Higher level equations are adequately presented.	The presentation could be improved in one or more areas but overall, adequately described.	Presentation of background and theory is cursory in certain areas and/or shows deficiency in preparation.
PROCEDURE & DATA: Is the procedure clearly presented? Are figures supported by the narrative? 0 - 20 points	Report fully meets these parameters.	The presentation could be improved in a few areas. Narrative does not fully support diagram of apparatus.	Procedure not clearly presented. Figures lacking or not supported by the narrative.
ANALYSIS: Does the report clearly explain how the results are obtained from the data? Is the error analysis clearly presented and followed from the procedure and data sections? 0 - 20 points	Report fully meets these parameters.	Presentation meets parameters. Parts of the analysis and/or error analysis have minor deficiencies.	Presentation is significantly lacking in one or more? areas.
CONCLUSION: Are the results well explained within the context of the background of the experiment? Are any deficiencies in procedure or analysis adequately presented? 0 - 10 points	Report fully meets these parameters.	Presentation meets parameters. Relation of the results to the background of the experiment could be improved.	Conclusion may be cursory and/or not well connected to the background of the experiment.

Results

Due to the restructuring of the Kopchik College of Natural Science and the loss of faculty, PHYS 350, Intermediate Experimental Physics, has not been offered for four years. Fortunately, we have written samples from the last time the course was offered, and they are used for this assessment. Samples from this course will continue to be used for biennial assessment.

Points	**CRITERIA**	**Scores on individual reports N=6**					
0- 10	ORGANIZATION	6	8	6	6	8	5
0-20	WRITING	18	17	18	16	17	18
0-20	BACKGROUND & THEORY	16	15	16	15	15	19
0-20	PROCEDURE & DATA	17	18	18	15	18	15
0-20	ANALYSIS	20	18	20	15	18	15
0-10	CONCLUSION	9	6	9	4	6	4
	Total	86	82	87	71	82	76

Number of samples in each category by criteria:

	Exemplary	Competent	Beginning
ORGANIZATION	2	3	1
WRITING	6	0	0
BACKGROUND & THEORY	3	3	0
PROCEDURE & DATA	4	2	0
ANALYSIS	4	2	0
CONCLUSION	2	2	2

Fall 2021 N = 6 students	Class average on Criteria (score)	Class average on Criteria (as a percentage)	Standing
ORGANIZATION	7	70%	Competent
WRITING	17	85%	Exemplary
BACKGROUND & THEORY	16	80%	Competent
PROCEDURE & DATA	17	85%	Exemplary
ANALYSIS	18	90%	Exemplary
CONCLUSION	6	60%	Beginning

In a typical research paper, the conclusion is critical, where error analysis and potential future studies are discussed. This analysis indicates that our majors need more practice and instruction in the area of summarizing and concluding the results of their experiment.

Recommendations from the WAC Director

Students in this sample are for the most part competent writers. Most are meeting or exceeding expectations in all but one criterion: Conclusions. Because these are baseline results, my suggestions for using these results over the next two years (before the next assessment in 2027) are as follows:

- Use a larger sample size to obtain results. This will help to ensure validity of the results and to see a broader range of student ability.
- Include a rater who is not the course instructor. These samples were rated by one faculty member who taught the course; a second rater may have interjected a slightly different perspective and encouraged a broader use of differing levels of the rubric.
- Look to ways to improve scores in Organization and Background & Theory. While samples were rated as competent in these areas, students who are meeting expectations are most likely to eventually exceed them with a little bit of support. Look for places in the course outcomes map to include scaffolding and emphasis in these two areas.