

Physics Practices for 2022-2023

These are the 10 practices that you will be developing over the course of this year in Physics.

LP1 – Experimental Design: The parts of the experimental design section are: the lab question, the methods and materials, the data and observations. The goal is to communicate what and how you did the data collection, with enough detail so that someone else can follow your work easily.

LP2 – Data Analysis (in a lab context): The goal is to communicate what and how you did the data analysis, with enough detail so that someone else can follow your work easily. A discussion about sources of experimental error is essential. The other parts of the analysis section may include any or all of the following: graphing (creation and interpretation), problem solving (set-up and theoretical derivation), sample calculations, and/or quantitative error analysis (percent error and/or difference).

LP3 – Arguing a Scientific Claim: The parts of the Arguing a Scientific Claim section are: the claim, the evidence, and the reasoning. The goal is to communicate the answer to the lab question, the best evidence you have for that answer, and how those results relate to the known physics theory.

LP4 - Using Feedback: The using feedback section is where you annotate your lab, highlighting the changes you made from the previous lab. The goal is to communicate what changes you made, why you made them, and how you have improved over time.

LP5 – Creating Explanations and Making Predictions: The goal is to show what physics you know and can apply from the current unit of study. The physics can take the form of overly stated definitions, laws, mathematical models, equations, or relationships.

LP6 – Problem Solving: The goal when solving scientific problems is to show the process used. This problem solving process includes givens and variables on a labeled sketch or illustration, diagrams (MD, FBD, Bar Charts), equations used, numbers plugged in, and an answer to the question asked. Units are necessary on all values.

LP7 – Graph Interpretation: The goal is to overtly use features of the graph accompanied by an explanation, to demonstrate your understanding of the physics. “Features” include coordinate pair(s), slope, graph shape, area, and/or y-intercept. When appropriate, a mathematical model is developed or interpreted. Some of these are more sophisticated than others, depending on the question.

LP8 – Graph Creation: The goal is to overtly create a graph, including all relevant features. This includes axes labeled with variables and units, a trendline, a descriptive title, plotted points, and any given or reference values on the axes (to scale when appropriate). An overtly stated physics relationship is presented, in the form of theory and/or mathematical model.

LP9 - Engaging with Content: The goal is to overtly encourage and develop creativity. Creativity requires flexible thinking, originality, fluency with concepts, and elaboration.

LP10 - The Engineering Design Cycle: The goal is to solve a real-world problem, generally by building something. The steps of the engineering design process include asking questions, brainstorming ideas, planning solutions, creating a design, testing and evaluating, then repeating this process through as many iterations as possible in the time provided to improve the product. This practice is divided into two parts to help you to develop the various components of this skill.

LP10.1 – Product Design (The Engineering Design Cycle): This practice assesses the effectiveness of the design as a solution to the given problem.

LP10.2 – Communication and Documentation (The Engineering Design Cycle): This practice assesses your ability to document the experimental design, all your progress, and your thinking.

**Learning Progressions 2022-2023
Physics Labs**

	Not Enough Evidence	Beginning	Developing	Proficient	Advanced	Expert
LP.1 – Experiment al Design	I did not include the task, data, and/or procedure.	I state the task. I collect and present data. I provide a description of the procedure followed.	I use the tools and equipment effectively to collect data related to the stated task and organize it into a table. I communicate the methods and materials used during the investigation.	I restate the task as a question that is directly related to the assigned task. I use the available measurement tools correctly. The data collected is complete and can be used to answer the question. The data table is well-organized. The methods and materials are descriptive enough for someone else to replicate the data collection during the experiment. I use a method to reduce experimental uncertainty, which is obvious in my data table.	I ask testable questions that are directly related to the assigned task. I can plan and implement precise and effective data collection strategies. The data table is well-constructed, including columns for analysis relevant to the lab. I communicate clearly, succinctly, and with sufficient detail, including labeled pictures. I explicitly describe a valid and effective method to reduce experimental uncertainty.	I ask an independently generated question. I independently develop an investigation that can produce data to answer that question. I independently carry out that investigation, collecting relevant data.
LP2 – Data Analysis (in a lab context)	I did not mention any source of experimental error nor complete any other data analysis.	I identify a single source of experimental error. I do some other relevant analysis, but it is either very basic or not useful.	I identify multiple sources of experimental error. I choose to do some relevant analyses. I may omit one or more significant analyses of the data.	I describe multiple, relevant sources of experimental error. I present one or more correct quantitative analyses of the data. I include the most significant analyses of the data. I use the available analysis tools correctly.	When correctly describing multiple, relevant sources of experimental error, I offer reasonable and specific suggestions to fix those sources of experimental error next time. I include all the most significant and effective analyses of the data, omitting none. It is done correctly. When appropriate, I use advanced analysis methods (such as linearization and/or interpretation of the mathematical model).	I predict the effects of experimental error on the experiment. I describe what I did to address sources of experimental error that I saw in previous labs, to avoid the same effects here. When appropriate, I correctly use advanced analysis methods (such as linearization and interpretation of the mathematical model).
LP3 – Arguing a Scientific Claim	I did not write a conclusion.	I write a conclusion.	I present a scientific claim regarding the relationship between relevant dependent and independent variables. I present evidence obtained from my investigations as support.	I present a scientific claim that accurately describes the relationship derived from my experimental results. I present convincing evidence. I state a physics concept, theory, or equation as reasoning.	I present the most convincing, valid and reliable evidence obtained from my investigations as support for my claim. I clearly state a relevant physics concept, theory, or equation as reasoning. The reasoning is clearly related to the variables in the claim. There is no extra/irrelevant information.	I effectively tie physics theory correctly, directly, and tightly to the most sophisticated supporting evidence available, so that my claim is clearly justified. I justify my claim by providing quantitative proof that the results reflect the theory.
LP.4 - Using Feedback	I did not identify changes that I made since the previous lab report.	I identify changes that I made since the previous lab report.	I describe at least 6 changes that I made since the previous lab report, correlated to feedback from my peers, the instructor, class discussion, or my own understanding of this rubric.	I explicitly state why changes needed to be made (or not made) based on relevant physics or skills requirements.	I correctly and appropriately make changes based upon the feedback received, or correctly state why I chose not to do so. In addition, I request specific feedback from the instructor, identifying areas with which I am uncertain or struggling.	I communicate and document the rationale behind alternate approaches to similar (but not identical) situations, based on feedback received prior to the current attempt. I communicate areas of weakness and document the methodical application of strategies that I used to improve.

**Learning Progressions 2022-2023
Physics Checkpoints (Tests and Quizzes)**

	Not Enough Evidence	Beginning	Developing	Proficient	Advanced	Expert
LP5 – Creating Explanations and Making Predictions	I do not answer the question and/or I do not explain my reasoning or make predictions.	I answer the question and I write an explanation or prediction that addresses the reason why I answered the question.	I use relevant terminology and/or state relevant Big Idea(s) in my explanation or prediction, using information from this unit.	While making an explanation or prediction, I can correctly choose and overtly state relevant physics.	I produce an accurate explanation or prediction that fully ties all of the relevant physics concepts to the correct answer, in a familiar situation.	I produce an accurate explanation or prediction for a complex situation. This may require the use of multiple steps and/or multiple Big Ideas, applying previously learned material when necessary.
LP6 – Problem Solving	I did not attempt to solve the problem described.	I attempt to solve the problem.	I attempt to solve scientific problems and show some relevant supporting work.	I solve scientific problems, showing my supporting work so that someone can follow my thought processes. This means that I show the work required to document the problem-solving process.	I select and apply the correct mathematical process to solve physics problems correctly in a familiar context, including all steps of the problem-solving process. Givens, variables, and answer(s) all include correct units. I use my calculator properly.	When presented with a complex context, I fully apply the problem-solving methodology to independently solve the problem correctly.
LP7 – Graph Interpretation	I do not use the graph to answer the question or to analyze experimental results.	I reference the graph when answering the question.	I use relevant feature(s) of the graph when answering a question or analyzing experimental results.	I overtly identify a correct feature(s), and overtly state its significance (aka why I am using it). When appropriate, I overtly present the relevant physics relationship shown in the graph, using words or equations. I use this to answer a question or analyze experimental results.	I present the correct physics relationship shown in the graph, using words or equations. I use this to correctly answer a question or analyze experimental results. When appropriate, I associate the mathematical model with relevant physics concepts.	The most sophisticated graph feature is correctly used, work is shown, and its significance correctly explained. When appropriate, I correctly associate the mathematical model with correct physics concepts, interpreting the features of the graph in terms of theoretical physics values.
LP8 – Graph Creation	I either do not create a graph, or attempt the graph but neglect to label the axes.	I create a graph, and the axes are labeled. This may be a loose sketch, hand-plotted on graph paper, or made on Excel, depending on the assessment.	I create a graph between the relevant independent and dependent variables; axes are labeled with variables and units. I include a trendline(s) for the graph.	The graph axes are labeled correctly. There are reference values on both axes. The trendline for the graph is selected based on an <u>overtly stated relationship</u> . (The shape must be in agreement with the stated relationship, although the relationship may be incorrect.)	The shape of the trendline, the relationship on which it is based, and any values on the axes are correct and overtly displayed. With multiple lines or parts, there is consistency in scale (values are correct with respect to each other, even without numbers). I generate the equation of the trendline, when appropriate.	I include the correct equation of the trendline, with accurate use of slope and y-int (or, if non-linear, the coefficient). I draw a correct graph in a complex situation, and/or correctly make predictions of how changes will affect the graph, using the features of the graph to justify my reasoning.

**Learning Progressions 2022-2023
Physics (Projects)**

	Not Enough Evidence	Beginning	Developing	Proficient	Advanced	Expert
<i>LP9 Engaging with Content *</i>	I demonstrate insufficient fluency with the unit concepts because I earned less than 75% on all of the content mastery checkpoints for the unit.	I demonstrate foundational fluency with the unit concepts by earning at least a 75% on any one of the content mastery checkpoints for the unit. I use no more than the allotted attempts.	I demonstrate foundational fluency with the unit concepts by earning at least 85% on 2 of the content mastery checkpoints for the unit. I overtly use terminology and concepts from this unit when discussing my thinking about this assignment. I brainstorm to generate ideas.	I demonstrate foundational fluency with the unit concepts by earning at least 95% on the most recent content mastery checkpoint for the unit. I correctly state physics concepts to explain my decision-making, experimental design, data analysis, and/or performance (good and poor). During brainstorming, I generate a large quantity and variety of ideas, providing clear rationale for my choices.	I correctly apply physics concepts from this unit to explain my decision-making, experimental design, data analysis, and performance (good and poor). During brainstorming, I demonstrate fluency by generating a wide variety of ideas. I demonstrate flexibility by weighing the pros and cons of each idea before choosing which variables to test.	I demonstrate fluency by fully integrating physics appropriately and correctly throughout all sections of the project. I demonstrate elaboration by providing detailed qualitative and quantitative proof that my project obeys the multiple laws of physics in this and other units. I demonstrate originality by significantly investigating some less likely, more unusual ideas from my brainstorming to see if they are feasible. I further demonstrate flexibility by investigating the effects of external variables on my design.
<i>LP10.1 – Product Design (The Engineering Design Cycle)**</i>	I do not present any relevant product.	I produce a product that meets the basic criteria When applicable, I build the base model.	I produce a product that seems to meet all criteria. I produce at least 3 different variations of the base model. Data (qualitative and/or quantitative) is presented.	I produce a product that overtly meets all criteria. Each version tests a distinct variable. Data collection is correctly done. Evidence for each prototype includes data organized in table(s). When appropriate, I overtly do quantitative analysis of my data, including sample calculations and/or theoretical derivation(s).	I can produce a product that effectively solves the problem. Each version tests three variations of each variable, with multiple trials for each. You collect meaningful, correct data presented in a well-constructed table(s). Any quantitative work is correctly completed and useful. This may be analysis of my data and/or the theoretical derivation. I choose and present a final prototype design based on my testing results.	I can produce a creative and effective product that meets all criteria. When appropriate, the efficient use of resources is a driving factor in the design process.
<i>LP10.2 – Communication and Documentation (The Engineering Design Cycle)**</i>	I do not present any documentation.	I submit evidence of the construction of my project.	I document the construction phases of my project, with photos and/or video. I outline what data I collected, how I collected it, and/or how it was analyzed/used. The evidence of construction of the project is revised and submitted multiple times.	I clearly document the development of my ideas, communicating the problem, needs, constraints, and any research/background information. I detail what data I collected, how I collected it, and how it was analyzed/used. I create a log or journal that is updated and shared regularly.	I fully document the methodical and iterative steps of the engineering design cycle. Someone else can replicate the process without any help. I include sample work and pictures. My log/journal communicates what was done, any problems and achievements, current thinking, and next steps.	My final presentation completely documents my understanding of the essential steps of the engineering design cycle by highlighting the details without being repetitive or off-topic. My log/journal is well-organized and easy to read. I include documented references to external resources when appropriate.

*This practice is about developing creativity. Guilford's model of Divergent Thinking from the 1950s provides a breakdown of four component skills that interact to become what people generally call "creativity." Although this analysis was around long before today's web 2.0 tools, it provides an insightful vocabulary and lens that teachers, students, and parents can use to help students think and work creatively. Guilford's four skills are fluency, flexibility, originality, and elaboration (FFOE for short). <https://www.teachersfirst.com/ISTE/CRE8/index.cfm>

**These two rows are ONE practice, separated to ease reading.