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 – Experimental 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
LP.5 – 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 overtly stated relationship. (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
LP9 Engaging with Content	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 complete all of the allotted attempts. I overtly use terminology and Big Ideas✪ from this unit when discussing my thinking about this assignment.	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 the Big Ideas to explain my decision-making, experimental design, data analysis, and/or performance (good and poor).	I correctly apply the Big Ideas from this unit to explain my decision-making, experimental design, data analysis, and performance (good and poor).	I fully integrate the Big Ideas appropriately and correctly throughout my discussion. I use Big Ideas from this unit as well as other relevant units.
LP10 The Engineering Design Process	I do not present any relevant product and/or evidence of using the EDP.	I build the base model. I use the steps of the engineering design process (EDP).** I submit evidence of the product.	I produce a product that addresses the assigned task. I communicate how I used the EDP in the evolution of my product.*** I present evidence of the product and use of the EDP.	I produce a product that meets all listed criteria. The Engineering Design Process shows the evolution of my product so that my thought process is easy to follow. I worked through the EDP multiple times.	My final product is the best possible model based on the collected data. I provide convincing evidence to link the collected data to the final design. My presentation documents the methodical and iterative* steps of the engineering design cycle to show how I developed my product.	The efficient use of resources is a driving factor in the design process. 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.

✪Big Ideas for each unit can be found on the Unit Overview pages which are handed out in class on the first day of the unit, posted on our Canvas page, and discussed (and applied) nearly every day.

*The steps of the Engineering Design Process are shown on the diagram to the right (linked here). An "iteration" is the repetition of a process. By its very nature, the EDP is meant to be a cyclical process where you go through the loop multiple times. You are never actually done with the process; you keep going until you simply run out of time. So, depending on how complex your variables are to test, you may be able to go through the process twice or ten times or anything in between!

**The presentation of the project will be defined in the assignment along with the task and its criteria. No matter what form it takes, you will need to communicate what you created and evidence of your understanding/use of the Engineering Design Process. Examples of acceptable presentation format include: a document, slideshow, a recording, screencast, a face-to-face oral presentation✤, poster, and/or journal. (✤If f2f, you must make an appointment on Canvas by the deadline.)

***We need to clearly define the term engineering vs. tinkering. Tinkering is not a bad word. It includes stabilizing, repairing, or refining your project. For example, if you build a car, and the wheels keep falling off, you might glue them on more securely. That's tinkering. So are things like adjusting the angle of the axles so that they are aligned. Engineering is when you are systematically testing a variable. Usually you can clearly identify the question that you are attempting to answer. For example, what happens if I use different types of wheels? What happens if I change the position of the axle attachment? To answer this question, you would have to go through the EDP: building, testing, collecting data, and evaluating that data.