The AP Physics 1: Algebra-Based Exam

Exam Information

The AP Physics 1 exam consists of two sections: multiple choice and free response. The exam is 3 hours long and includes a multiple-choice section and a free-response section of one hour and 30 minutes each. The multiple-choice section accounts for half of each student's exam grade, and the free-response section accounts for the other half. Both sections include questions aligned to the learning objectives and their associated science practices in order to assess students' ability to:

- Provide both qualitative and quantitative explanations, reasoning, or justification of physical phenomena, grounded in physics principles and theories
- Solve problems mathematically — including symbolically — but with less emphasis on only mathematical routines used for solutions
- Interpret and develop conceptual models
- Transfer knowledge and analytical skills developed during laboratory experiences to design and describe experiments and analyze data and draw conclusions based on evidence.

Section I in the AP Physics 1 exam consists of 50 multiple-choice questions, either as discrete questions, questions in sets, or multi-correct questions that represent the knowledge and science practices outlined in the AP Physics 1 learning objectives in the course framework, which students should understand and be able to apply. Multi-correct questions will be in a separate section of the multiple-choice portion of the exam (Part B) and will indicate to students to select the two correct options for each question in the stimulus.

Section II contains three types of free-response questions that each student will have a total of one hour and 30 minutes to complete. The three question types are:

- Experimental design — Pertains to designing and describing an investigation, analysis of authentic lab data, and observations to identify patterns or explain phenomena
- Qualitative/quantitative translation — Requires translating between quantitative and qualitative justification and reasoning
- Short-answer questions — One of which will require a paragraph-length coherent argument

Section	Timing	Scoring	Question Type	Number of Questions
I: Multiple Choice	One hour and 30 minutes	50% of exam score	**Part A:** Multiple Choice – Discrete Items and Items in Sets	45
			Part B: Multiple Correct – Items with two correct answers	5
				Total – 50
II: Free Response	One hour and 30 minutes	50% of exam score	Experimental Design	1
			Qualitative/Quantitative Translation	1
			Short-Answer	3
				Total – 5

The sample exam questions in this course and exam description represent the kinds of questions that are included on the AP Physics 1 exam. The concepts, content, application of science practices, and level of difficulty in these sample questions are comparable to what students will encounter on an actual AP Exam. Each sample multiple-choice and free-response question is followed by a text box that shows each question's alignment with the learning objectives and science practices provided in the AP Physics 1 course framework.

Multiple-choice questions will contain four answer options. A student's total score on the multiple-choice section is based on the number of questions answered correctly. Points are not deducted for incorrect answers or unanswered questions.

Student Work for Free-Response Sections

In scoring the free-response sections, credit for the answers depends on the quality of the solutions and the explanations given; partial solutions may receive partial credit, so students are advised to *show all their work*. Correct answers without supporting work may lose credit. This is especially true when students are asked specifically to justify their answers, in which case the AP Exam Readers are looking for some verbal or mathematical analysis that shows how the students arrived at their answers. Also, all final numerical answers should include appropriate units.

Terms Defined

On the AP Physics 1 exam the words "describe," "explain," "justify," "calculate," "derive," "what is," "determine," "sketch," "plot," "draw," "label," "design," and "outline" have precise meanings.

Students should pay careful attention to these words in order to obtain maximum credit and should avoid including irrelevant or extraneous material in their answers.

- Students will be asked both to "**describe**" and "**explain**" natural phenomena. Both terms require the ability to demonstrate an understanding of physics principles by providing an accurate and coherent description or explanation. Students will also be asked to "**justify**" a previously given answer. A justification is an argument supported by evidence. Evidence may consist of statements of physical principles, equations, calculations, data, graphs, and diagrams as appropriate. The argument, or equations used to support justifications and explanations, may in some cases refer to fundamental ideas or relations in physics, such as Newton's laws, conservation of energy, or Bernoulli's equation. In other cases, the justification or explanation may take the form of analyzing the behavior of an equation for large or small values of a variable in the equation.
- "**Calculate**" means that a student is expected to show work leading to a final answer, which may be algebraic but more often is numerical. "**Derive**" is more specific and indicates that the students need to begin their solutions with one or more fundamental equations, such as those given on the AP Physics 1 Exam equation sheet. The final answer, usually algebraic, is then obtained through the appropriate use of mathematics. "**What is**" and "**determine**" are indicators that work need not necessarily be explicitly shown to obtain full credit. Showing work leading to answers is a good idea, as it may earn a student partial credit in the case of an incorrect answer. Strict rules regarding significant digits are usually not applied to the scoring of numerical answers. However, in some cases, answers containing too many digits may be penalized. In general, two to four significant digits are acceptable. Exceptions to these guidelines usually occur when rounding makes a difference in obtaining a reasonable answer.

- The words "**sketch**" and "**plot**" relate to student-produced graphs. "Sketch" means to draw a graph that illustrates key trends in a particular relationship, such as slope, curvature, intercept(s), or asymptote(s). Numerical scaling or specific data points are not required in a sketch. "Plot" means to draw the data points given in the problem on the grid provided, either using the given scale or indicating the scale and units when none are provided.
- Exam questions that require the drawing of free-body or force diagrams will direct the students to "**draw** and **label** the forces (not components) that act on the [object]," where [object] is replaced by a reference specific to the question, such as "the car when it reaches the top of the hill." Any components that are included in the diagram will be scored in the same way as incorrect or extraneous forces. In addition, in any subsequent part asking for a solution that would typically make use of the diagram, the following will be included: "If you need to draw anything other than what you have shown in part [x] to assist in your solution, use the space below. Do NOT add anything to the figure in part [x]." This will give students the opportunity to construct a working diagram showing any components that are appropriate to the solution of the problem. This second diagram will not be scored.
- Some questions will require students to "**design**" an experiment or "**outline**" a procedure that investigates a specific phenomenon or would answer a guiding question. Students are expected to provide an orderly sequence of statements that specifies the necessary steps in the investigation needed to reasonably answer the question or investigate the phenomenon.

The Paragraph-Length Response

A paragraph-length response to a question should consist of a coherent argument that uses the information presented in the question and proceeds in a logical, expository fashion to arrive at a conclusion.

AP Physics students are asked to give a paragraph-length response so that they may demonstrate their ability to communicate their understanding of a physical situation in a reasoned, expository analysis. A student's response should be a coherent, organized, and sequential description of the analysis of a situation. The response should argue from evidence, cite physical principles, and clearly present the student's thinking to the reader. The presentation should not include extraneous information. It should make sense on the first reading.

The style of the exposition is to explain and/or describe, like a paragraph, rather than present a calculation or a purely algebraic derivation, and should be of moderate length, not long and elaborate.

A paragraph-length response will earn points for correct physics principles, as does a response to any other free-response question. However, full credit may not be earned if a paragraph-length response contains any of the following: principles not presented in a logical order, lengthy digressions within an argument, or primarily equations or diagrams with little linking prose.

On the AP Physics 1 exam the argument may include, as needed, diagrams, graphs, equations, and perhaps calculations to support the line of reasoning. The style of such a response may be seen in the example problems in textbooks, which are typically a mix of prose statements, equations, diagrams, etc., that present an orderly analysis of a situation.

To reiterate, the goal is that students should be able to both analyze a situation and construct a coherent, sequenced, well-reasoned exposition that cites evidence and principles of physics and that makes sense on the first reading.

Expectations for the Analysis of Uncertainty

On the AP Physics 1 exam, students will not need to calculate uncertainty but will need to demonstrate understanding of the principles of uncertainty. In general, multiple-choice questions on the AP Physics 1 exam will deal primarily with qualitative assessment of uncertainty, while free-response laboratory questions may require some quantitative understanding of uncertainty as described below.

Experiment and data analysis questions on the AP Physics 1 exam will not require students to calculate standard deviations or carry out the propagation of error or a linear regression. Students will be expected to estimate a line of best fit to data that they plot or to a plot they are given. Students may be expected to discuss which measurement or variable in a procedure contributes most to overall uncertainty in the final result and on conclusions drawn from a given data set. They should recognize that there may be no significant difference between two reported measurements if they differ by less than the smallest difference that can be discerned on the instrument used to make the measurements. They should be able to reason in terms of percentage error and to report results of calculations to an appropriate number of significant digits. Students are also expected to be able to articulate the effects of error and error propagation on conclusions drawn from a given data set and how results and conclusions would be affected by changing the number of measurements, measurement techniques, or the precision of measurements. Students should be able to review and critique an experimental design or procedure and decide whether the conclusions can be justified based on the procedure and the evidence presented.

Calculators and Equation Tables

Students will be allowed to use a calculator on the entire AP Physics 1 exam — including both the multiple-choice and free-response sections. Scientific or graphing calculators may be used, provided that they don't have any unapproved features or capabilities. A list of approved graphing calculators is available at https://apstudent.collegeboard.org/takingtheexam/exam-policies/calculator-policy. Calculator memories do not need to be cleared before or after the exam. Since graphing calculators can be used to store data, including text, proctors should monitor that students are using their calculators appropriately. Communication between calculators is prohibited during the exam administration. Attempts by students to use the calculator to remove exam questions and/or answers from the room may result in the invalidation of AP Exam scores. The policy regarding the use of calculators on the AP Physics 1 exam was developed to address the rapid expansion of the capabilities of calculators, which include not only programming and graphing functions but also the availability of stored equations and other data. Students should be allowed to use the calculators to which they are accustomed. However, students should be encouraged to develop their skills in estimating answers and orders of magnitude quickly and in recognizing answers that are physically unreasonable or unlikely.

Tables containing equations commonly used in physics will be provided for students to use during the entire AP Physics 1 exam. In general, the equations for each year's exam are printed and distributed with the course and exam description at least a year in advance so that students can become accustomed to using them throughout the year. However, because the equation tables will be provided with the exam, students will NOT be allowed to bring their own copies to the exam room. The latest version of the equations and formulas list is included in Appendix B to this course and exam description. One of the purposes of providing the tables of commonly employed equations for use with the exam is to address the issue of equity for those students who do not have access to equations stored in their calculators. The availability of these equations to all students means that in the scoring of the exam, little or no credit will be awarded for simply writing down equations or for answers unsupported by explanations or logical development.

In general, the purpose of allowing calculators and equation sheets to be used in both sections of the exam is to place greater emphasis on the understanding and application of fundamental physical principles and concepts. For solving problems and writing essays, a sophisticated scientific or graphing calculator, or the availability of stored equations, is no substitute for a thorough grasp of the physics involved.

Time Management

Students need to learn to manage their time to allow them to complete all parts of the exam. Time left is announced by proctors, but students are not forced to move to the next question; thus if they do not properly budget their time, they may not wind up with enough time to complete all the multiple-choice questions in Section I and all the free-response questions in Section II. Students often benefit from taking a practice exam under timed conditions prior to the actual administration.