



## Flipping Physics Lecture Notes:

Experimental Design Questions for AP Physics Explained!  
<http://www.flippingphysics.com/experimental-design.html>

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Links to my solutions to the Free Response Questions from publicly released, past AP Physics 1 exams and the category for each of those Free Response Questions.<sup>1</sup>

Please see my previous video, “QQT and PASA for AP Physics Explained”, for a discussion of the AP Physics 1 exam and all the different categories of questions.<sup>2</sup>

“When presented with an experimental design question, students often do not know where to start.”<sup>3</sup>

I think it is good to begin by acknowledging that students often struggle with the experimental design question. It requires designing a hypothetical experiment and that can be intimidating. Please, heed my advice in this video and practice with as many free response questions as you can. Did I mention I have solutions for those?

“This question type assesses student ability to design and describe a scientific investigation, analyze authentic laboratory data, and identify patterns or explain phenomena.”<sup>4</sup>

Again, you are going to design an experiment. Often you will be asked to look at raw data, determine how to rearrange that data in order to prove properties of physics, and be able to recognize relationships within the data.

“Students must be able to justify their selection of the kind of data needed to answer the question and then design a plan to collect that data.”<sup>5</sup>

Sometimes you are not provided with data, but rather you are asked what data would need to be collected to prove physics phenomena. And then you are asked to design an experiment that will allow for collection of that data.

“Students should be prepared to offer evidence, construct reasoned arguments for their claim from the evidence, and use the claim or explanation to make predictions.”<sup>6</sup>

You will also be asked to defend your choices using logical reasoning. When you do so, please use my suggestions about Paragraph Argument Short Answer. Let’s now talk about specifics of AP Physics Experimental Design Questions (EDQs). Let’s start with 2016 AP Physics 1 Free Response Question #2 part (a):

**(a) Design an experiment to test the student’s hypothesis about collisions of the ball with a hard surface. The student has equipment that would usually be found in a school physics laboratory.**

- Notice the question asks you to “design an experiment”. Clearly every one of the EDQs will ask you to “design an experiment”.
  - When deciding on your lab setup and experimental design, simpler is often better.

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<sup>1</sup> <https://www.flippingphysics.com/ap-physics-1-review.html>

<sup>2</sup> <http://www.flippingphysics.com/qqt-pasa.html>

<sup>3</sup> From page 33 of the 2020 AP Physics 1 Course and Exam Description (CED).

<https://apstudents.collegeboard.org/ap/pdf/ap-physics-1-course-and-exam-description.pdf>

<sup>4</sup> Page 206 of the 2020 CED.

<sup>5</sup> Page 33 of the 2020 CED.

<sup>6</sup> Page 198 of the 2020 CED

- I would recommend reading all the way through part (b) of this question before beginning to answer any questions. This is typical of EDQs. When designing the experiment, you need to understand all the requirements of the experiment.
  - Think all the way through the experiment and do not rush to answer each question before answering the next question. You need to think about answering the questions in total, not individually.
    - For example, deciding how to represent the data in a graph affects what experiment you are going to perform and what data to collect.
  - When you “describe your procedure”, do not include extraneous steps like “collect all lab equipment” or “sharpen my pencil” or “meditate to clear your mind in preparation for accurate data collection”.
  - You will likely be asked to draw an experimental setup and to **label** the items. Please make sure you actually label the items. The AP graders should not have to guess what objects it is you have drawn.
  - You may be given a list of possible lab equipment and asked to choose which pieces to use. 2012 #2 APC: Mechanics
- Chances are very good you will be required to create a graph (see above). When you do:
    - Label both axes (include units).
    - Plot data carefully.
    - Pick axes scales such that you use more than half the graph.
    - When drawing the best fit line, a good approximation is to have half the data points above and half the data points below the best fit line.
    - Creating a graph, plotting data, adding a best fit line, and then comparing the slope to an accepted value is an effective way to “construct reasoned arguments for (your) claim from the evidence, and use the claim or explanation to make predictions.”
    - You may be asked to estimate a graph based on changes to the data. Graphs **will** come up on the AP Physics exams.
  - Likely you will be asked what your data will look like if the experiment appears to violate a law of physics. Or the converse, what could have gone wrong in the experiment if there are errors in the given data.
    - Part (c) of 2016 AP Physics 1 FRQ #2.
    - Also 2017 #2, data table, they want you to recognize that something went wrong with data collection in Lab Group #5.
  - Could be asked how the data will change if a part of the experiment is changed. For example, doubling the mass of an object.
  - Please read carefully!
    - For example, “include steps necessary to reduce experimental uncertainty” or “In your diagram, indicate each quantity that would be measured”.
      - To reduce experimental uncertainty, not only do you need to perform multiple trials, you also need to make adjustments to the data you are collecting.
        - This has come up a few times.
      - Do not include extraneous measurements.
    - They may ask for “a symbol for each measurement”. AP C: Mechanics 2012 #2.
    - Be careful of the statement “in terms of the quantities measured”. AP C: Mechanics 2012 #2 part (c).
    - Always explain or justify your answer when asked to on the exam.
  - If you have time, when you are done, go back and read the question carefully to make sure you have included everything they ask for.

How do we start designing an experiment?

- Start by looking at all the possible equations.
- Experiments are about relationships between variables.
- Find equations which relate the applicable variables.
- Determine which variables need to be identified and measured.
- Determine which lab equipment is necessary to measure those variables.
- Equations help visualize graphs and slopes of best-fit lines of data.

Study for exam:

- Identify physical object which represent equations.
- Look over labs/problems and identify objects which go with equations.

Best of luck on the AP Physics exams y'all!

My video: "Graphing Rotational Inertia of an Irregular Shape" is a good example of an EDQ.<sup>7</sup>

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<sup>7</sup> <https://www.flippingphysics.com/graphing-rotational-inertia.html>