

AP[®]

The AP[®] Physics Science Practices

Unit: Laboratory & Measurement

NGSS Standards/MA Curriculum Frameworks (2016): SP1, SP2, SP3, SP4, SP5, SP6, SP7

AP[®] Physics 2 Learning Objectives/Essential Knowledge (2024): SP1, SP2, SP3, SP4, SP5, SP6, SP7

Mastery Objective(s): (Students will be able to...)

- Describe what the College Board and the State of Massachusetts want you to know about how science is done.

Tier 2 Vocabulary: data, claim, justify

Language Objectives:

- Explain the what the student is expected to do for each of the AP[®] Science Practices.

Tier 2 Vocabulary: practice, pose, model

Notes:

The College Board has described the scientific method in practical terms, dividing them into seven Science Practices that students are expected to learn in AP Physics 1.

Science Practice 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.

A model is any mental concept that can explain and predict how something looks, works, is organized, or behaves. Atomic theory is an example of a model: matter is made of atoms, which are made of protons, neutrons, and electrons. The number, location, behavior and interactions of these sub-atomic particles explains and predicts how different types of matter behave.

- 1.1 The student can *create representations and models* of natural or man-made phenomena and systems in the domain.
- 1.2 The student can *describe representations and models* of natural or man-made phenomena and systems in the domain.
- 1.3 The student can *refine representations and models* of natural or man-made phenomena and systems in the domain.
- 1.4 The student can *use representations and models* to analyze situations or solve problems qualitatively and quantitatively.
- 1.5 The student can express key elements of natural phenomena across multiple representations in the domain.

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Science Practice 2: The student can use mathematics appropriately.

Physics is the representation of mathematics in nature. It is impossible to understand physics without a solid understand of mathematics and how it relates to physics. For AP Physics 1, this means having an intuitive feel for how algebra works, and how it can be used to relate quantities or functions to each other. If you are the type of student who solves algebra problems via memorized procedures, you may struggle to develop the kind of mathematical understanding that is necessary in AP Physics 1.

- 2.1 The student can justify the selection of a mathematical routine to solve problems.
- 2.2 The student can *apply mathematical routines* to quantities that describe natural phenomena.
- 2.3 The student can *estimate numerically quantities* that describe natural phenomena.

Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

Ultimately, the answer to almost any scientific question is “maybe” or “it depends”. Scientists pose questions to understand not just what happens, but the extent to which it happens, the causes, and the limits beyond which outside factors become dominant.

- 3.1 The student can pose scientific questions.
- 3.2 The student can refine scientific questions.
- 3.3 The student can evaluate scientific questions.

Science Practice 4: The student can plan and implement data collection strategies in relation to a particular scientific question.

Scientists do not “prove” things. Mathematicians and lawyers prove that something must be true. Scientists collect data in order to evaluate what happens under specific conditions, in order to determine what is likely true, based on the information available. Data collection is important, because the more and better the data, the more scientists can determine from it.

- 4.1 The student can *justify the selection of the kind of data* needed to answer a particular scientific question.
- 4.2 The student can *design a plan* for collecting data to answer a particular scientific question.
- 4.3 The student can *collect data* to answer a particular scientific question.

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4.4 The student can *evaluate sources of data* to answer a particular scientific question.

Science Practice 5: The student can perform data analysis and evaluation of evidence.

Just as data collection is important, analyzing data and being able to draw meaningful conclusions is the other crucial step to understanding natural phenomena. Scientists need to be able to recognize patterns that actually exist within the data, and to be free from the bias that comes from expecting a particular result beforehand.

5.1 The student can *analyze data* to identify patterns or relationships.

5.2 The student can *refine observations and measurements* based on data analysis.

5.3 The student can *evaluate the evidence provided by data sets* in relation to a particular scientific question.

Science Practice 6: The student can work with scientific explanations and theories.

In science, there are no “correct” answers, only claims and explanations. A scientific claim is any statement that is believed to be true. In order to be accepted, a claim must be verifiable based on evidence, and any claim or explanation must be able to make successful predictions, which are also testable. Science does not prove claims to be universally true or false; science provides supporting evidence. Other scientists will accept or believe a claim provided that there is sufficient evidence to support it, and no evidence that directly contradicts it.

6.1 The student can justify claims with evidence.

6.2 The student can *construct explanations of phenomena based on evidence* produced through scientific practices.

6.3 The student can articulate the reasons that scientific explanations and theories are refined or replaced.

6.4 The student can make *claims and predictions about natural phenomena* based on scientific theories and models.

6.5 The student can evaluate alternative scientific explanations.

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Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

If a scientific principle is true in one domain, scientists must be able to consider that principle in other domains and apply their understanding from the one domain to the other. For example, conservation of momentum is believed by physicists to be universally true on every scale and in every domain, and it has implications in the contexts of laboratory-scale experiments, quantum mechanical behaviors at the atomic and sub-atomic levels, and special relativity.

7.1 The student can *connect phenomena and models* across spatial and temporal scales.

7.2 The student can *connect concepts* in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.