1

AP PHYSICS 1

Science Practices

The table that follows presents the science practices that students should develop during the AP Physics 1 course. These practices form the basis of many tasks on the AP Physics 1 Exam.

The unit guides that follow embed and spiral these practices throughout the course, providing teachers with one way to integrate the practices into the course content with sufficient repetition to prepare students to transfer those science practices when taking the AP Physics 1 Exam.

More detailed information about teaching the science practices can be found in the Instructional Approaches section of this publication.

AP PHYSICS 1

Science Practices

Practice 1	Practice 2	Practice 3	Practice 4	Practice 5	Practice 6	Practice 7
***Modeling* 1**	***Mathematical Routines* 2**	***Scientific Questioning* 3**	***Experimental Methods* 4**	***Data Analysis* 5**	***Argumentation* 6**	***Making Connections* 7**
The student can use representations and models to communicate scientific phenomena and solve scientific problems.	The student can use mathematics appropriately.	The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course *(not assessed on the AP Exam).*	The student can plan and implement data-collection strategies in relation to a particular scientific question.	The student can perform data analysis and evaluation of evidence.	The student can work with scientific explanations and theories.	The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.
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 re-express key elements of natural phenomena across multiple representations in the domain.	**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 quantities that describe natural phenomena.	**3.1** The student can pose scientific questions. **3.2** The student can refine scientific questions. **3.3** The student can evaluate scientific questions.	**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. **4.4** The student can evaluate sources of data to answer a particular scientific question.	**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.	**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.	**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.

2 AP PHYSICS 1

Course Content

Based on the Understanding by Design® (Wiggins and McTighe) model, this course framework provides a clear and detailed description of the course requirements necessary for student success. The framework specifies what students must know, be able to do, and understand, with a focus on six big ideas that encompass core principles, theories, and processes of physics. The framework also encourages instruction that prepares students to make connections across domains through a broader way of thinking about the physical world.

Big Ideas

The big ideas serve as the foundation of the course and allow students to create meaningful connections among concepts. They are often abstract concepts or themes that become threads that run throughout the course. Revisiting the big ideas and applying them in a variety of contexts allows students to develop deeper conceptual understanding. Below are the big ideas of the course and a brief description of each.

BIG IDEA 1: SYSTEMS (SYS)

Objects and systems have properties such as mass and charge. Systems may have internal structure.

BIG IDEA 2: FIELDS (FLD)

Fields existing in space can be used to explain interactions.

BIG IDEA 3: FORCE INTERACTIONS (INT)

The interactions of an object with other objects can be described by forces.

BIG IDEA 4: CHANGE (CHA)

Interactions between systems can result in changes in those systems.

BIG IDEA 5: CONSERVATION (CON)

Changes that occur as a result of interactions are constrained by conservation laws.

BIG IDEA 6: WAVES (WAV)

Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.

UNITS

The course content is organized into commonly taught units. The units have been arranged in a logical sequence frequently found in many college courses and textbooks.

The 10 units in AP Physics 1 and their relevant weightings on the multiple-choice section of AP Exam are listed below.

Pacing recommendations at the unit level and on the Course at Glance provide suggestions for how teachers can cover both the required course content and the Personal Progress Checks. The suggested class periods are based on a schedule in which the class meets five days a week for 45 minutes each day. While these recommendations have been made to aid in planning, teachers are free to adjust the pacing based on the needs of their students, alternate schedules (e.g., block scheduling), or their school's academic calendar.

TOPICS

Each unit is divided into teachable segments called topics. Visit the topic pages (starting on page 36) to see all required content for each topic.

Exam Weighting for the Multiple-Choice Section of the AP Exam

Units	**Exam Weighting**
Unit 1: *Kinematics*	**10–16%**
Unit 2: *Dynamics*	**12–18%**
Unit 3: *Circular Motion and Gravitation*	**4–6%**
Unit 4: *Energy*	**16–24%**
Unit 5: *Momentum*	**10–16%**
Unit 6: *Simple Harmonic Motion*	**2–4%**
Unit 7: *Torque and Rotational Motion*	**10–16%**
Unit 8: *Electric Charge and Electric Force*	**4–6%**
Unit 9: *DC Circuits*	**6–8%**
Unit 10: *Mechanical Waves and Sound*	**12–16%**

Spiraling the Big Ideas

The following table shows how the big ideas spiral across units by showing the units in which each big idea appears.

Big Ideas	**Unit 1** *Kinematics*	**Unit 2** *Dynamics*	**Unit 3** *Circular Motion and Gravitation*	**Unit 4** *Energy*	**Unit 5** *Momentum*	**Unit 6** *Simple Harmonic Motion*	**Unit 7** *Torque and Rotational Motion*	**Unit 8** *Electric Charge and Electric Force*	**Unit 9** *DC Circuits*	**Unit 10** *Mechanical Waves and Sound*
1-Systems **SYS**		✓	✓					✓	✓	
2-Fields **FLD**		✓	✓							
3-Force Interactions **INT**	✓	✓	✓	✓	✓	✓	✓	✓		
4-Change **CHA**	✓	✓	✓	✓	✓		✓			
5-Conservation **CON**				✓	✓	✓	✓	✓	✓	
6-Waves **WAV**										✓

Course at a Glance

Plan

The Course at a Glance provides a useful visual organization of the AP Physics 1 course components, including:

- Sequence of units, along with approximate weighting and suggested pacing. Please note, pacing is based on 45-minute class periods, meeting five days each week for a full academic year.
- Progression of topics within each unit.
- Spiraling of the big ideas and science practices across units.

Teach

PRACTICES/SKILL CATEGORIES

Science practices spiral throughout the course.

- 1 Modeling
- 2 Mathematical Routines
- 3 Scientific Questioning
- 4 Experimental Methods
- 5 Data Analysis
- 6 Argumentation
- 7 Making Connections

+ Indicates 3 or more science pratices for a given topic. The individual topic page will show all the science practices.

BIG IDEAS

Big ideas spiral across topics and units.

- SYS 1-Systems
- FLD 2-Fields
- INT 3-Force Interactions
- CHA 4-Change
- CON 5-Conservation
- WAV 6-Waves

Assess

Assign the Personal Progress Checks—either as homework or in class—for each unit. Each Personal Progress Check contains formative multiple-choice and free-response questions. The feedback from these checks shows students the areas where they need to focus.

UNIT 1 Kinematics

~16–19 Class Periods | **10–16%** AP Exam Weighting

INT	+	1.1	Position, Velocity, and Acceleration
CHA	+	1.2	Representations of Motion

Personal Progress Check 1

Multiple-choice: ~15 questions
Free-response: 2 questions

- Experimental Design
- Paragraph Argument Short Answer

UNIT 2 Dynamics

~19–22 Class Periods | **12–18%** AP Exam Weighting

SYS	1 7	2.1	Systems
FLD	2 7	2.2	The Gravitational Field
INT	6	2.3	Contact Forces
SYS	4	2.4	Newton's First Law
INT	+	2.5	Newton's Third Law and Free-Body Diagrams
INT	+	2.6	Newton's Second Law
CHA	+	2.7	Applications of Newton's Second Law

Personal Progress Check 2

Multiple-choice: ~40 questions
Free-response: 2 questions

- Quantitative/Qualitative Translation
- Short Answer

UNIT 3 Circular Motion and Gravitation

~7–9 Class Periods **4–6%** AP Exam Weighting

- FLD **3.1** Vector Fields
- INT 7 **3.2** Fundamental Forces
- INT 2 7 **3.3** Gravitational and Electric Forces
- FLD 2 7 **3.4** Gravitational Field/Acceleration Due to Gravity on Different Planets
- SYS 4 **3.5** Inertial vs. Gravitational Mass
- CHA 5 **3.6** Centripetal Acceleration and Centripetal Force
- INT + **3.7** Free-Body Diagrams for Objects in Uniform Circular Motion
- INT + **3.8** Applications of Circular Motion and Gravitation

Personal Progress Check 3

Multiple-choice: ~40 questions
Free-response: 2 questions

- Experimental Design
- Paragraph Argument Short Answer

UNIT 4 Energy

~19–22 Class Periods **16–24%** AP Exam Weighting

- CON 6 7 **4.1** Open and Closed Systems: Energy
- INT CHA + **4.2** Work and Mechanical Energy
- CON + **4.3** Conservation of Energy, the Work-Energy Principle, and Power

Personal Progress Check 4

Multiple-choice: ~30 questions
Free-response: 2 questions

- Quantitative/Qualitative Translation
- Short Answer

UNIT 5 Momentum

~12–15 Class Periods **10–16%** AP Exam Weighting

- INT + **5.1** Momentum and Impulse
- CHA + **5.2** Representations of Changes in Momentum
- CON 6 7 **5.3** Open and Closed Systems: Momentum
- CON + **5.4** Conservation of Linear Momentum

Personal Progress Check 5

Multiple-choice: ~35 questions
Free-response: 2 questions

- Experimental Design
- Paragraph Argument Short Answer

UNIT 6 Simple Harmonic Motion

~2–5 Class Periods | **2–4%** AP Exam Weighting

INT +
6.1 Period of Simple Harmonic Oscillators

CON +
6.2 Energy of a Simple Harmonic Oscillator

Personal Progress Check 6

Multiple-choice: ~20 questions
Free-response: 2 questions

- Experimental Design
- Short Answer

UNIT 7 Torque and Rotational Motion

~12–17 Class Periods | **10–16%** AP Exam Weighting

INT 1 2
7.1 Rotational Kinematics

INT +
7.2 Torque and Angular Acceleration

CHA +
7.3 Angular Momentum and Torque

CHA +
7.4 Conservation of Angular Momentum

Personal Progress Check 7

Multiple-choice: ~40 questions
Free-response: 2 questions

- Quantitative/Qualitative Translation
- Paragraph Argument Short Answer

UNIT 8 Electric Charge and Electric Force

~3–5 Class Periods | **4–6%** AP Exam Weighting

CON 6 7
8.1 Conservation of Charge

SYS +
8.2 Electric Charge

INT +
8.3 Electric Force

Personal Progress Check 8

Multiple-choice: ~15 questions
Free-response: 2 questions

- Quantitative/Qualitative Translation
- Paragraph Argument Short Answer

UNIT 9 DC Circuits

~9–12 Class Periods | **6–8%** AP Exam Weighting

SYS 6 7	**9.1** Definition of a Circuit
SYS 4	**9.2** Resistivity
CON +	**9.3** Ohm's Law, Kirchhoff's Loop Rule (Resistors in Series and Parallel)
CON +	**9.4** Kirchhoff's Junction Rule, Ohm's Law (Resistors in Series and Parallel)

Personal Progress Check 9

Multiple-choice: ~30 questions
Free-response: 2 questions

- Experimental Design
- Short Answer

UNIT 10 Mechanical Waves and Sound

~11–14 Class Periods | **12–16%** AP Exam Weighting

WAV +	**10.1** Properties of Waves
WAV +	**10.2** Periodic Waves
WAV +	**10.3** Interference and Superposition (Waves in Tubes and on Strings)

Personal Progress Check 10

Multiple-choice: ~30 questions
Free-response: 2 questions

- Quantitative/Qualitative Translation
- Paragraph Argument Short Answer