AP® PHYSICS 2

BEGINNING 2014-15 ACADEMIC YEAR

About the Advanced Placement Program® (AP®)

The Advanced Placement Program® enables willing and academically prepared students to pursue college-level studies — with the opportunity to earn college credit, advanced placement, or both — while still in high school. AP Exams are given each year in May. Students who earn a qualifying score on an AP Exam are typically eligible to receive college credit and/or placement into advanced courses in college. Every aspect of AP course and exam development is the result of collaboration between AP teachers and college faculty. They work together to develop AP courses and exams, set scoring standards, and score the exams. College faculty review every AP teacher's course syllabus.

AP Physics Program

The AP Program offers four physics courses: AP Physics 1: Algebra-based, AP Physics 2: Algebra-based, AP Physics C: Mechanics, and AP Physics C: Electricity and Magnetism.

Guided by the National Research Council and National Science Foundation, the AP Program collaborated with college and university educators and AP teachers to develop two, yearlong AP Physics courses to replace AP Physics B.

AP Physics 1: Algebra-based and AP Physics 2: Algebra-based are the equivalent of the first and second semesters of an introductory, algebra-based college course. Because these courses are intended to be yearlong courses, teachers have time to foster deeper conceptual understanding through student-centered, inquiry-based instruction. Students have time to master foundational physics principles while engaging in science practices to earn credit or placement.

In addition, there are two AP Physics C courses: Physics C: Mechanics and Physics C: Electricity and Magnetism. Each corresponds to one semester of an introductory, calculus-based college course. Physics C: Mechanics is taught prior to Physics C: Electricity and Magnetism.

AP Physics 2: Algebra-Based Course Overview

AP Physics 2 is an algebra-based, introductory college-level physics course that explores topics such as fluid statics and dynamics; thermodynamics with kinetic theory; PV diagrams and probability; electrostatics; electrical circuits with capacitors; magnetic fields; electromagnetism; physical and geometric optics; and quantum, atomic, and nuclear physics. Through inquiry-based learning, students will develop scientific critical thinking and reasoning skills.

LABORATORY REQUIREMENT

This course requires that 25 percent of the instructional time will be spent in hands-on laboratory work, with an emphasis on inquiry-based investigations that provide students with opportunities to apply the science practices.

PREREQUISITE

Students should have had AP Physics 1 or a comparable introductory course.

Students should have taken or be concurrently taking precalculus or an equivalent course.

AP Physics 2: Algebra-Based Course Content

Students explore principles of fluids, thermodynamics, electricity, magnetism, optics, and topics in modern physics. The course is based on seven Big Ideas, which encompass core scientific principles, theories, and processes that cut across traditional boundaries and provide a broad way of thinking about the physical world. The following are Big Ideas:

- Objects and systems have properties such as mass and charge. Systems may have internal structure.
- Fields existing in space can be used to explain interactions.
- The interactions of an object with other objects can be described by forces.
- Interactions between systems can result in changes in those systems.
- Changes that occur as a result of interactions are constrained by conservation laws.
- 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.
- The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.

Science Practices

Students establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Focusing on these disciplinary practices enables teachers to use the principles of scientific inquiry to promote a more engaging and rigorous experience for AP Physics students. Such practices require that students:

- Use representations and models to communicate scientific phenomena and solve scientific problems;
- Use mathematics appropriately;
- Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course;
- Plan and implement data collection strategies in relation to a particular scientific question;
- Perform data analysis and evaluation of evidence;
- Work with scientific explanations and theories; and
- Connect and relate knowledge across various scales, concepts, and representations in and across domains.

Inquiry-Based Investigations

Twenty-five percent of instructional time is devoted to hands-on laboratory work with an emphasis on inquiry-based investigations. Investigations will require students to ask questions, make observations and predictions, design experiments, analyze data, and construct arguments in a collaborative setting, where they direct and monitor their progress.

AP Physics 2 Exam Structure

AP PHYSICS 2 EXAM: 3 HOURS

Assessment Overview

Exam questions are based on learning objectives, which combine science practices with specific content. Students learn to:

- Solve problems mathematically — including symbolically
- Design and describe experiments and analyze data and sources of error
- Explain, reason, or justify answers with emphasis on deeper, conceptual understanding
- Interpret and develop conceptual and mathematical models

Format of Assessment

Section I: Multiple Choice: 50 Questions | 90 Minutes | 50% of Exam Score

- Discrete items
- Items in sets
- Multimark items (two options will be correct)

Section II: Free Response: 4 Questions | 90 Minutes | 50% of Exam Score

- Experimental Design (1 question)
- Quantitative/Qualitative Translation (1 question)
- Short Answer (2 questions, one requiring a paragraph-length argument)

AP PHYSICS 2 SAMPLE EXAM QUESTIONS

Sample Multiple-Choice Question

A student writes the following information for a process that involves a fixed quantity of ideal gas.

$W = -P\Delta V$

$\Delta U = Q + W$

$P = 2.0\text{x}10^5\text{Pa}$

$\Delta V = -2.0\text{x}10^{-3}\text{m}^3$

$\Delta U = -600J$

Which of the following descriptions best represents the process?

(A) The gas expands at a constant pressure of 200 kPa.

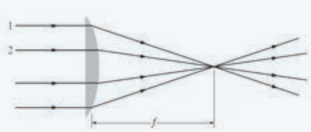
(B) The gas is cooled at constant volume until its pressure falls to 200 kPa.

(C) The gas is compressed at a constant pressure of 200 kPa.

(D) The gas is heated and its pressure increases at constant volume.

Correct Answer: C

Sample Free-Response Question: Experimental Design



Quantitative/Qualitative Translation

The figure at left represents a glass lens that has one flat surface and one curved surface. After incoming parallel rays pass through the lens, the rays pass through a focal point.

(A) The rays undergo refraction and change direction at the right surface of the lens, as shown. Explain why the angle of refraction of ray 1 is greater than that of ray 2.

(B) The index of refraction of the glass is n_{glass}, and the radius of curvature of the lens's right edge is R. (The radius of curvature is the radius of the sphere of which that edge is a part. A smaller R corresponds to a lens that curves more). A teacher who wants to test a class's understanding about lenses asks the students if the equation $f = n_{glass}R$ makes sense for the focal length of the lens in air. Is the teacher's equation reasonable for determination of the focal length? Qualitatively explain your reasoning, making sure you address the dependence of the focal length on both R and n_{glass}.

(C) An object is placed a distance $f / 2$ (half of the focal length) to the left of the lens. On which side of the lens does the image form, and what is its distance from the lens in terms of f? Justify your answer. (Assume this is a thin lens.)

(D) The lens is now placed in water, which has an index of refraction that is greater than air but less than the glass. Indicate below whether the new focal length is greater than, less than, or equal to the focal length f in air.

____ Greater than in air

____ Less than in air

____The same as in air

Justify your answer qualitatively, with no equations or calculations.

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