AP®

SAMPLE QUESTIONS

AP® Physics 1 and AP® Physics 2 Exams

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AP Physics 1: Algebra-Based and
AP Physics 2: Algebra-Based Curriculum Framework

CollegeBoard

The College Board

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The College Board strongly encourages educators to make equitable access a guiding principle for their AP programs by giving all willing and academically prepared students the opportunity to participate in AP. We encourage the elimination of barriers that restrict access to AP for students from ethnic, racial, and socioeconomic groups that have been traditionally underserved. Schools should make every effort to ensure their AP classes reflect the diversity of their student population. The College Board also believes that all students should have access to academically challenging course work before they enroll in AP classes, which can prepare them for AP success. It is only through a commitment to equitable preparation and access that true equity and excellence can be achieved.

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Introduction

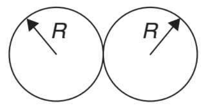
These sample exam questions were originally included in the *AP Physics 1: Algebra-Based and AP Physics 2: Algebra-Based Curriculum Framework,* published in fall 2012. The *AP Physics 1 and 2 Course and Exam Description,* which is out now, includes that curriculum framework, along with a new, unique set of exam questions. Because we want teachers to have access to all available questions that support the new exam, we are making those from the fall 2012 curriculum framework available in this supplementary document.

The sample exam questions illustrate the relationship between the curriculum framework and the redesigned AP Physics 1 and 2 Exam, and they serve as examples of the types of questions that appear on the exam.

Each question is followed by the targeted learning objective(s) from the curriculum framework. These sample questions help illustrate how the learning objectives for both courses are assessed. For multiple-choice questions, the correct answer is provided.

AP Physics 1: Algebra-Based Sample Exam Questions

Sample Multiple-Choice Questions



1. Two solid spheres of radius R made of the same type of steel are placed in contact, as shown in the figures above. The magnitude of the gravitational force that they exert on each other is F_1. When two other solid spheres of radius $3R$ made of this steel are placed in contact, what is the magnitude of the gravitational force that they exert on each other?

(A) F_1

(B) $3F_1$

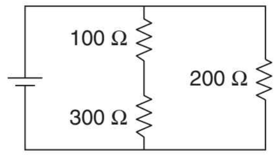
(C) $9F_1$

(D) $81F_1$

Answer: D

Targeted Learning Objective:

Learning Objective (3.C.1.1): The student is able to use Newton's law of gravitation to calculate the gravitational force the two objects exert on each other and use that force in contexts other than orbital motion. [See Science Practice 2.2]



2. The figure above shows three resistors connected in a circuit with a battery. Which of the following correctly ranks the energy E dissipated in the three resistors during a given time interval?

(A) $E_{300\Omega} > E_{200\Omega} > E_{100\Omega}$

(B) $E_{300\Omega} > E_{100\Omega} > E_{200\Omega}$

(C) $E_{200\Omega} > E_{300\Omega} > E_{100\Omega}$

(D) $E_{200\Omega} > E_{100\Omega} > E_{300\Omega}$

Answer: C

Targeted Learning Objectives:

Learning Objective (5.B.9.3): The student is able to apply conservation of energy (Kirchhoff's loop rule) in calculations involving the total electric potential difference for complete circuit loops with only a single battery and resistors in series and/or in, at most, one parallel branch. [See Science Practices 2.2, 6.4, and 7.2]

Learning Objective (5.C.3.1): The student is able to apply conservation of electric charge (Kirchhoff's junction rule) to the comparison of electric current in various segments of an electrical circuit with a single battery and resistors in series and in, at most, one parallel branch and predict how those values would change if configurations of the circuit are changed. [See Science Practices 6.4 and 7.2]

3. A person driving a car suddenly applies the brakes. The car takes 4 s to come to rest while traveling 20 m at constant acceleration. Can the speed of the car immediately before the brakes were applied be determined without first determining the car's acceleration?

(A) Yes, by dividing the distance (20 m) by the time (4 s).

(B) Yes, by determining the average speed while braking and doubling it.

(C) No, because the acceleration is needed to use standard equations such as $\Delta x = v_o t + \frac{1}{2} a t^2$.

(D) No, because the fundamental relationship that defines velocity contains acceleration.

Answer: B

Targeted Learning Objectives:

Learning Objective (3.A.1.1): The student is able to express the motion of an object using narrative, mathematical, and graphical representations. [See Science Practices 1.5, 2.1, and 2.2]

Learning Objective (4.A.2.1): The student is able to make predictions about the motion of a system based on the fact that acceleration is equal to the change in velocity per unit time, and velocity is equal to the change in position per unit time. [See Science Practice 6.4]

4. While traveling in its elliptical orbit around the Sun, Mars gains speed during the part of the orbit where it is getting closer to the Sun. Which of the following can be used to explain this gain in speed?

   (A) As Mars gets closer to the Sun, the Mars–Sun system loses potential energy and Mars gains kinetic energy.

   (B) A component of the gravitational force exerted on Mars is perpendicular to the direction of motion, causing an acceleration and hence a gain in speed along that direction.

   (C) The torque exerted on Mars by the Sun during this segment of the orbit increases the Mars–Sun system's angular momentum.

   (D) The centripetal force exerted on Mars is greater than the gravitational force during this segment of the orbit, causing Mars to gain speed as it gets closer to the Sun.

   Answer: A

Targeted Learning Objectives:

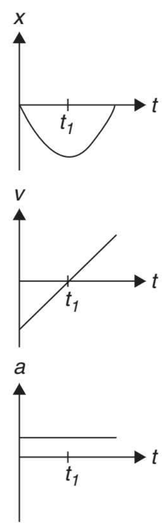
Learning Objective (3.B.1.1): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations with acceleration in one dimension. [See Science Practices 6.4 and 7.2]

Learning Objective (3.E.1.1): The student is able to make predictions about the changes in kinetic energy of an object based on considerations of the direction of the net force on the object as the object moves. [See Science Practices 6.4 and 7.2]

Learning Objective (4.C.2.1): The student is able to make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass. [See Science Practice 6.4]

Learning Objective (5.B.4.1): The student is able to describe and make predictions about the internal energy of systems. [See Science Practices 6.4 and 7.2]

Learning Objective (5.E.2.1): The student is able to describe or calculate the angular momentum and rotational inertia of a system in terms of the locations and velocities of objects that make up the system. Students are expected to do qualitative reasoning with compound objects. Students are expected to do calculations with a fixed set of extended objects and point masses. [See Science Practice 2.2]



5. The graphs above represent the position x, velocity v, and acceleration a as a function of time t for a marble moving in one dimension. Which of the following could describe the motion of the marble?

   (A) Rolling along the floor and then bouncing off a wall

   (B) Rolling down one side of a bowl and then rolling up the other side

   (C) Rolling up a ramp and then rolling back down

   (D) Falling and then bouncing elastically off a hard floor

   Answer: C

Targeted Learning Objective:

Learning Objective (3.A.1.1): The student is able to express the motion of an object using narrative, mathematical, and graphical representations. [See Science Practices 1.5, 2.1, and 2.2]

Multi-Correct: Students need to select all the correct answers to the question below in order to earn credit.

6. A race car going around a flat, unbanked circular track gradually increases speed as it completes one full trip around the track. Which of the following can explain why the car gains speed?

   (A) Energy stored in the fuel is converted to mechanical energy.

   (B) A component of the frictional force exerted by the ground on the tires is directed toward the center of the circle.

   (C) A component of the frictional force exerted by the ground on the tires is in the direction of motion.

   (D) The car's velocity and acceleration are perpendicular.

   Answer: A and C

Targeted Learning Objectives:

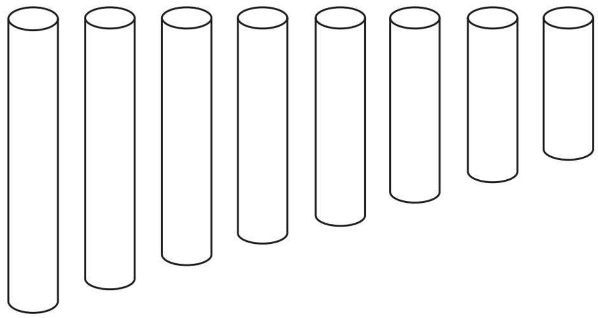
Learning Objective (3.E.1.1): The student is able to make predictions about the changes in kinetic energy of an object based on considerations of the direction of the net force on the object as the object moves. [See Science Practices 6.4 and 7.2]

Learning Objective (3.E.1.2): The student is able to use net force and velocity vectors to determine qualitatively whether kinetic energy of an object would increase, decrease, or remain unchanged. [See Science Practice 1.4]

Learning Objective (4.C.2.1): The student is able to make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass. [See Science Practice 6.4]

Sample Free-Response Questions

Experimental Design



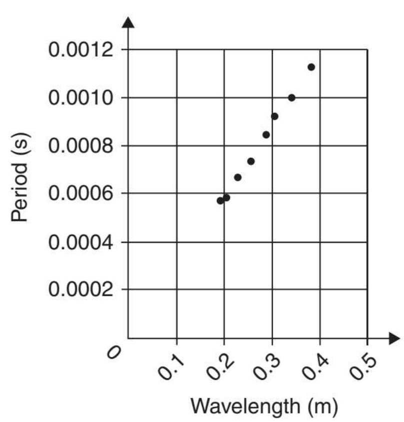
1. You are given a set of chimes that consists of eight hollow metal tubes open at both ends, as shown above. The chimes are played by striking them with a small hammer to produce musical sounds. Your task is to use the chimes to determine the speed of sound in air at room temperature. You have available a set of tuning forks and other common laboratory equipment but are not allowed to use electronic equipment, such as a sound sensor. (A tuning fork vibrates when struck and produces sound at a particular frequency, which is printed on the tuning fork.)

   (a) Describe your experimental procedure in enough detail so that another student could perform your experiment. Include what measurements you will take and how you will take them.

   (b) Describe how you will use your measurements to determine the speed of sound, in enough detail that another student could duplicate your process.

   (c) Describe one assumption you made about the design of your experiment, and explain how it might affect the value obtained for the speed of sound.

   (d) A student doing a different experiment to determine the speed of sound in air obtained wavelength and period measurements and created the following plot of the data. Use the graph to calculate the speed of sound and include an explanation of your method.

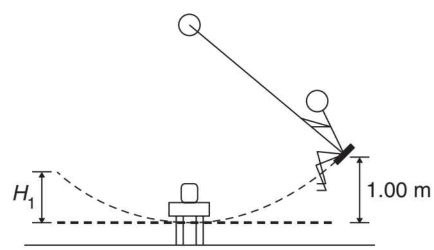


Targeted Learning Objectives:

Learning Objective (6.B.4.1): The student is able to design an experiment to determine the relationship between periodic wave speed, wavelength, and frequency and relate these concepts to everyday examples. [See Science Practices 4.2, 5.1, and 7.2]

Learning Objective (6.D.3.3): The student is able to plan data collection strategies, predict the outcome based on the relationship under test, perform data analysis, evaluate evidence compared to the prediction, explain any discrepancy and, if necessary, revise the relationship among variables responsible for establishing standing waves on a string or in a column of air. [See Science Practices 3.2, 4.1, 5.1, 5.2, and 5.3]

Short Answer



Note: Figure not drawn to scale.

2. A student of mass 50.0 kg swings on a playground swing, which is very light compared to the student. A friend releases the seat of the swing from rest at a height of 1.00 m above the lowest point of the motion. The student swings down and, at the lowest point of the motion, grabs a jug of water of mass 4.00 kg. The jug is initially at rest on a small table right next to the swing, so it does not move vertically as the student grabs it. The student keeps swinging forward while holding the jug, and the seat reaches a maximum height H_1 above the lowest point. Air resistance and friction are negligible.

(a) Indicate whether H_1 is greater than, less than, or equal to 1.00 m.

_____ Greater than 1.00 m

_____ Less than 1.00 m

_____ Equal to 1.00 m

Justify your answer qualitatively, with no equations or calculations.

(b) Explain how H_1 can be calculated. You need not actually do the calculations, but provide complete instructions so that another student could use them to calculate H_1.

(c) The student now swings backward toward the starting point. At the lowest point of the motion, the student drops the water jug. Indicate whether the new maximum height that the seat reaches is greater than, less than, or equal to H_1.

_____ Greater than H_1

_____ Less than H_1

_____ Equal to H_1

Justify your answer.

Targeted Learning Objectives:

Learning Objective (5.B.4.2): The student is able to calculate changes in kinetic energy and potential energy of a system, using information from representations of that system. [See Science Practices 1.4, 2.1, and 2.2]

Learning Objective (5.D.1.3): The student is able to apply mathematical routines appropriately to problems involving elastic collisions in one dimension and justify the selection of those mathematical routines based on conservation of momentum and restoration of kinetic energy. [See Science Practices 2.1 and 2.2]

Learning Objective (5.D.2.1): The student is able to qualitatively predict, in terms of linear momentum and kinetic energy, how the outcome of a collision between two objects changes depending on whether the collision is elastic or inelastic. [See Science Practices 6.4 and 7.2]

Learning Objective (5.D.2.3): The student is able to apply the conservation of linear momentum to a closed system of objects involved in an inelastic collision to predict the change in kinetic energy. [See Science Practices 6.4 and 7.2]

Learning Objective (5.D.2.5): The student is able to classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum as the appropriate solution method for an inelastic collision, recognize that there is a common final velocity for the colliding objects in the totally inelastic case, solve for missing variables, and calculate their values. [See Science Practices 2.1 and 2.2]