Preparing for the AP Physics Exam

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Preparing for the
AP Physics Exam

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I. Understanding the AP Physics Exam

The AP Physics B Exam takes three hours, and it is composed of two distinct sections.
A section containing 70 multiple-choice questions makes up half of the exam, and the other half
is a free-response section composed of multipart questions. Each multiple-choice question offers
five potential answers in a familiar standardized testing format.
As in 2004, the free-response section of the Physics B exam in 2005 will be slightly shorter than
in the past, containing a total of 80 instead of 90 points. It will consist of two 15-point questions
and five 10-point questions. However, the time allotment of 90 minutes for this section will
remain the same, and the multiple-choice and free-response sections will still be weighted so that
they each contribute 50 percent toward the total grade.

The AP Physics C Exam consists of two parts. One part covers mechanics, the other part
electricity and magnetism. Each exam is one-and-a-half hours long. A student may take either or
both parts, and a separate grade is reported for each. In addition, the time for each part is divided
equally between a 35-question multiple-choice section and a section with three free-response
questions.

Section I: Multiple-Choice Questions

Calculators are not permitted during Section I of the exam. The relatively easy mathematical
manipulation involved does not require their use, as numerical values are chosen to keep
computation simple. Furthermore, the five potential answers listed for each question often differ
to such a great degree that the correct choice can be determined by estimation. It would be useful
for students to practice estimating calculated values.

The AP Physics Exam contains the following types of questions:
   Conceptual questions
   Computation questions: one-step and multiple-step
   Variable manipulation questions
   Graphical analysis questions
   Diagram-based questions
   Other types of questions

Note: All examples have been taken from the 1998 Released Exams.

Conceptual Questions

This type of question does not require a mathematical solution. Understanding the principles that underlie physics concepts is important as is knowing the relationships among variables. Some examples are:

B1. A solid metal ball and a hollow plastic ball of the same external radius are released from rest in a large vacuum chamber. When each has fallen 1 m, they both have the same
(A) inertia   (B) speed   (C) momentum   (D) kinetic energy   (E) change in potential energy

B55. In an experiment, light of a particular wavelength is incident on a metal surface, and electrons are emitted from the surface as a result. To produce more electrons per unit time but with less kinetic energy per electron, the experimenter should do which of the following?
(A) Increase the intensity and decrease the wavelength of the light.
(B) Increase the intensity and the wavelength of the light.
(C) Decrease the intensity and the wavelength of the light.
(D) Decrease the intensity and increase the wavelength of the light.
(E) None of the above would produce the desired result.

B64. Two parallel conducting plates, separated by a distance d, are connected to a battery of emf ε. Which of the following is correct if the plate separation is doubled while the battery remains connected?
(A) The electric charge on the plates is doubled.
(B) The electric charge on the plates is halved.
(C) The potential difference between the plates is doubled.
(D) The potential difference between the plates is halved.
(E) The capacitance is unchanged.

Questions 7–8 refer to a ball that is tossed straight up from the surface of a small, spherical asteroid with no atmosphere. The ball rises to a height equal to the asteroid's radius and then falls straight down toward the surface of the asteroid.

C7. What forces, if any, act on the ball while it is on the way up?
(A) Only a decreasing gravitational force that acts downward
(B) Only an increasing gravitational force that acts downward
(C) Only a constant gravitational force that acts downward
(D) Both a constant gravitational force that acts downward and a decreasing force that acts upward
(E) No forces act on the ball.

C8. The acceleration of the ball at the top of its path is
(A) at its maximum value for the ball's flight
(B) equal to the acceleration at the surface of the asteroid
(C) equal to one-half the acceleration at the surface of the asteroid
(D) equal to one-fourth the acceleration at the surface of the asteroid
(E) zero

C52. In which of the following cases does there exist a nonzero magnetic field that can be conveniently determined by using Ampere's law?
(A) Outside a point charge that is at rest
(B) Inside a stationary cylinder carrying a uniformly distributed charge
(C) Inside a very long current-carrying solenoid
(D) At the center of a current-carrying loop of wire
(E) Outside a square current-carrying loop of wire

Sometimes multiple-choice questions ask the student to identify the correct item or items from a list labeled with **roman numerals**. Some examples are:

B5. Units of power include which of the following?
  I. Watt
  II. Joule per second
  III. Kilowatt-hour
  (A) I only   (B) III only   (C) I and II only   (D) II and III only   (E) I, II, and III

B7. Three forces act on an object. If the object is in translational equilibrium, which of the following must be true?
  I. The vector sum of the three forces must equal zero.
  II. The magnitudes of the three forces must be equal.
  III. All three forces must be parallel.
  (A) I only   (B) II only   (C) I and III only   (D) II and III only   (E) I, II, and III

B11. Which of the following experiments provided evidence that electrons exhibit wave properties?
  I. Millikan oil-drop experiment
  II. Davisson-Germer electron-diffraction experiment
  III. J. J. Thomson's measurement of the charge-to-mass ratio of electrons
  (A) I only   (B) II only   (C) I and III only   (D) II and III only   (E) I, II, and III

B12. Quantities that are conserved in all nuclear reactions include which of the following?
  I. Electric charge
  II. Number of nuclei
  III. Number of protons
  (A) I only   (B) II only   (C) I and III only   (D) II and III only   (E) I, II, and III

C11. A satellite of mass M moves in a circular orbit of radius R with constant speed V. True statements about this satellite include which of the following?
  I. Its angular speed is V/R.
  II. Its tangential acceleration is zero.
  III. The magnitude of its centripetal acceleration is constant.
  (A) I only   (B) II only   (C) I and III only   (D) II and III only   (E) I, II, and III

Sometimes multiple-choice questions ask the student to select items **from two or three columns**. Some examples are:

B27. When light passes from air into water, the frequency of the light remains the same. What happens to the speed and the wavelength of light as it crosses the boundary in going from air into water?

Speed	Wavelength
(A) Increases	Remains the same
(B) Remains the same	Decreases
(C) Remains the same	Remains the same
(D) Decreases	Increases
(E) Decreases	Decreases

C2. The velocity of a projectile at launch has a horizontal component V_h and a vertical component V_v. Air resistance is negligible. When the projectile is at the highest point of its trajectory, which of the following show the vertical and horizontal components of its velocity and the vertical component of its acceleration?

	Vertical Velocity	Horizontal Velocity	Vertical Acceleration
(A)	V_v	V_h	0
(B)	V_v	0	0
(C)	0	V_h	0
(D)	0	0	g
(E)	0	V_h	g

Computation Questions

These questions require basic application of physical concepts through mathematical computation. Students need to recall the equation that governs the relationships between the given quantities and, finally, to perform the required computation and produce an exact numerical answer. Examples are:

B2. A student weighing 700 N climbs at constant speed to the top of an 8 m vertical rope in 10 s. The average power expended by the student to overcome gravity is most nearly
(A) 1.1 W   (B) 87.5 W   (C) 560 W   (D) 875 W   (E) 5,600 W

B20. A certain coffeepot draws 4.0 A of current when it is operated on 120 V household lines. If electrical energy costs 10 cents per kilowatt-hour, how much does it cost to operate the coffeepot for 2 hours?
(A) 2.4 cents   (B) 4.8 cents   (C) 8.0 cents   (D) 9.6 cents   (E) 16 cents

B28. A physics student places an object 6.0 cm from a converging lens of focal length 9.0 cm. What is the magnitude of the magnification of the image produced?
(A) 0.6   (B) 1.5   (C) 2.0   (D) 3.0   (E) 3.6

B70. A 4 µF capacitor is charged to a potential difference of 100 V. The electrical energy stored in the capacitor is
(A) 2×10^{-10} J   (B) 2×10^{-8} J   (C) 2×10^{-6} J   (D) 2×10^{-4} J   (E) 2×10^{-2} J

Sometimes multiple-choice questions include solutions that should be calculated as **estimations**. One example is:

Questions 46–47
A magnetic field of 0.1 T forces a proton beam of 1.5 mA to move in a circle of radius 0.1 m. The plane of the circle is perpendicular to the magnetic field.

B46. Of the following, which is the best estimate of the work done by the magnetic field on the protons during one complete orbit of the circle?
(A) 0 J   (B) 10^{-22} J   (C) 10^{-5} J   (D) 10^2 J   (E) 10^{20} J

B47. Of the following, which is the best estimate of the speed of a proton in the beam as it moves in the circle?
(A) 10^{-2} m/s   (B) 10^3 m/s   (C) 10^6 m/s   (D) 10^8 m/s   (E) 10^{15} m/s

Multistep Computation Questions

Sometimes your calculations may require more than one step to solve a problem. As opposed to basic computation, such questions are more accurately described as multistep computation. Here are some examples.
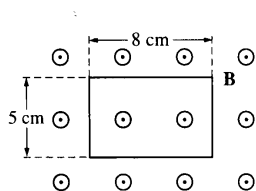
B19. A rectangular wire loop is at rest in a uniform magnetic field **B** of magnitude 2 T that is directed out of the page. The loop measures 5 cm by 8 cm, and the plane of the loop is perpendicular to the field, as shown above. The total magnetic flux through the loop is
(A) zero   (B) 2×10^{-3} T•m^2 (C) 8×10^{-3} T•m^2 (D) 2×10^{-1} T•m^2 (E) 8×10^{-1} T•m

B57. A ball of mass 0.4 kg is initially at rest on the ground. It is kicked and leaves the kicker's foot with a speed of 5.0 m/s in a direction 60° above the horizontal. The magnitude of the impulse imparted by the ball to the foot is most nearly

(A) 1 N•s   (B) $\sqrt{3}$ N•s   (C) 2 N•s   (D) $\dfrac{2}{\sqrt{3}}$ N•s   (E) 4 N•s

Variable-Manipulation Questions

Some problems require manipulation of symbolic variables rather than numerical solutions. The answers will be in variable form. Some examples are:

B3. A railroad car of mass m is moving at speed v when it collides with a second railroad car of mass M which is at rest. The two cars lock together instantaneously and move along the track. What is the speed of the cars immediately after the collision?

(A) $\dfrac{v}{2}$ (B) $\dfrac{mv}{M}$ (C) $\dfrac{mv}{m}$ (D) $\dfrac{(m+M)v}{m}$ (E) $\dfrac{mv}{m+M}$

B9. A child pushes horizontally on a box of mass m which moves with constant speed v across a horizontal floor. The coefficient of friction between the box and the floor is μ. At what rate does the child do work on the box?
(A) $\mu\,mgv$ (B) mgv (C) $v/\mu\,mg$ (D) $\mu\,mg/v$ (E) $\mu\,mv^2$

B39. An object has a weight W when it is on the surface of a planet of radius R. What will be the gravitational force on the object after it has been moved to a distance of $4R$ from the center of the planet?
(A) $16W$ (B) $4W$ (C) W (D) 4 (E) $1/16\ W$

B40. What is the kinetic energy of a satellite of mass m that orbits the Earth, of mass M, in a circular orbit of radius R?

(A) Zero   (B) $\dfrac{1}{2}\dfrac{GMm}{R}$ (C) $\dfrac{1}{4}\dfrac{GMm}{R}$ (D) $\dfrac{1}{2}\dfrac{GMm}{R^2}$ (E) $\dfrac{GMm}{R^2}$

Questions 59–60
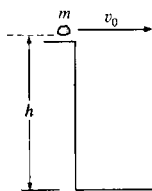
A rock of mass m is thrown horizontally off a building from a height h, as shown above. The speed of the rock as it leaves the thrower's hand at the edge of the building is v_0.
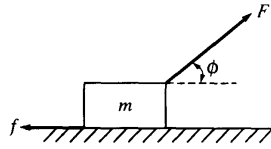
B59. How much time does it take the rock to travel from the edge of the building to the ground?

(A) $\sqrt{hv_o}$ (B) h/v_0 (C) hv_0/g (D) $2h/g$ $\dfrac{2h}{g}$ (E) $\sqrt{2h/g}$

B60. What is the kinetic energy of the rock just before it hits the ground?
(A) mgh (B) $\tfrac{1}{2}\,mv_0^2$ (C) $\tfrac{1}{2}\,mv_0^2 - mgh$ (D) $\tfrac{1}{2}\,mv_0^2 + mgh$ (E) $mgh - \tfrac{1}{2}\,mv_0^2$

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A block of mass m is accelerated across a rough surface by a force of magnitude F that is exerted at an angle ϕ with the horizontal, as shown above. The frictional force on the block exerted by the surface has magnitude f.
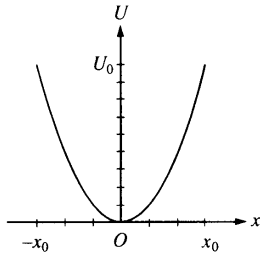
C21. What is the acceleration of the block?

(A) $\dfrac{F}{m}$ (B) $\dfrac{F\cos\phi}{m}$ (C) $\dfrac{F-f}{m}$ (D) $\dfrac{F\cos\phi-f}{m}$ (E) $\dfrac{F\sin\phi-mg}{m}$

C22. What is the coefficient of friction between the block and the surface?

(A) f/mg (B) mg/f (C) $(mg - F\cos\phi)/f$ (D) $f/(mg - F\cos\phi)$ (E) $f/(mg - F\sin\phi)$

Graphical-Analysis Questions

Still other multiple-choice questions are heavily dependent on graphical reasoning. Some examples are:

B8. The graph above represents the potential energy U as a function of displacement x for an object on the end of a spring oscillating in simple harmonic motion with amplitude x_0. Which of the following graphs represents the kinetic energy K of the object as a function of displacement x?
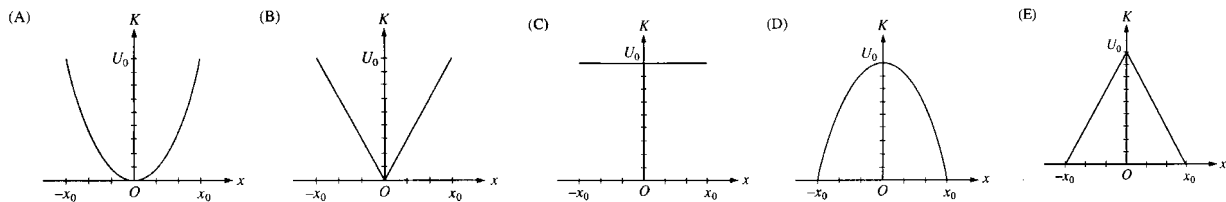

Questions 43–44
Three objects can only move along a straight, level path. The graphs below show the position d of each of the objects plotted as a function of time t.
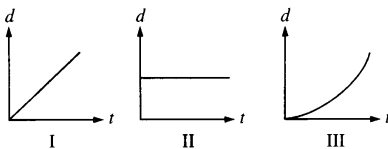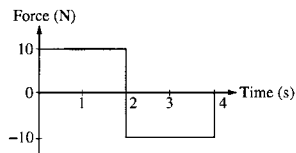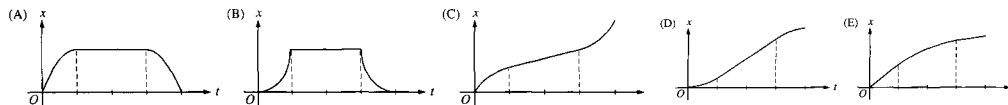

B43. The magnitude of the momentum of the object is increasing in which of the cases?

(A) II only   (B) III only   (C) I and II only   (D) I and III only   (E) I, II, and III

B44. The sum of the forces on the object is zero in which of the cases?

    (A) II only   (B) III only   (C) I and II only   (D) I and III only   (E) I, II, and III
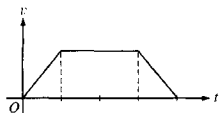
C3. The graph above shows the velocity V as a function of time t for an object moving in a straight line. Which of the following graphs shows the corresponding displacement x as a function of time t for the same time interval?


C12. The graph above shows the force on an object of mass M as a function of time. For the time interval 0 to 4 s, the total change in the momentum of the object is

    (A) 40 kg•m/s   (B) 20 kg•m/s   (C) 0 kg•m/s   (D) –20 kg•m/s

    (E) indeterminable unless the mass M of the object is known

Diagram-Based Questions

These questions require the interpretation of diagrams or the use of diagrams to obtain more information. Here are some examples:

Questions 15–16 refer to the following diagram that shows part of a closed electrical circuit.
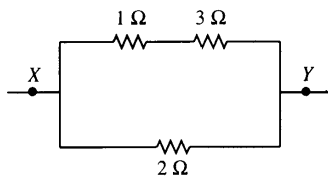

B15. The electrical resistance of the part of the circuit shown between point X and point Y is

    (A) $1\frac{1}{3}\,\Omega$ (B) $2\,\Omega$ (C) $2\frac{3}{4}\,\Omega$ (D) $4\,\Omega$ (E) $6\,\Omega$

B16. When there is a steady current in the circuit, the amount of charge passing a point per unit of time is

    (A) the same everywhere in the circuit   (B) greater at point X than at point Y

    (C) greater in the 1 Ω resistor than in the 2 Ω resistor   (D) greater in the 1 Ω resistor than in the 3 Ω resistor

    (E) greater in the 2 Ω resistor than in the 3 Ω resistor
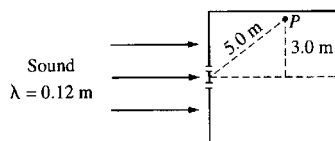
B51. Plane sound waves of wavelength 0.12 m are incident on two narrow slits in a box with nonreflecting walls, as shown above. At a distance of 5.0 m from the center of the slits, a first-order maximum occurs at point P, which is 3.0 m from the central maximum. The distance between the slits is most nearly

    (A) 0.07 m   (B) 0.09 m   (C) 0.16 m   (D) 0.20 m   (E) 0.24 m
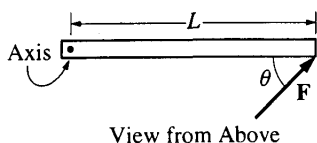
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Questions 17–18
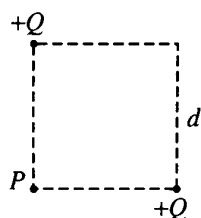
The figure above shows two particles, each with a charge of $+Q$ that are located at the opposite corners of a square of side d.

B17. What is the direction of the net electric field at point P?

(A)   (B)   (C)   (D)   (E)

B18. What is the potential energy of a particle of charge $+q$ that is held at point P?

(A) Zero   (B) $\dfrac{\sqrt{2}}{4\pi\varepsilon_0}\dfrac{qQ}{d}$ (C) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{qQ}{d}$ (D) $\dfrac{2}{4\pi\varepsilon_0}\dfrac{qQ}{d}$ (E) $\dfrac{2\sqrt{2}}{4\pi\varepsilon_0}\dfrac{qQ}{d}$

View from Above

B68. A rod on a horizontal tabletop is pivoted at one end and is free to rotate without friction about a vertical axis, as shown above. A force **F** is applied at the other end, at an angle θ to the rod. If **F** were to be applied perpendicular to the rod, at what distance from the axis should it be applied in order to produce the same torque?

(A) L sin θ (B) L cos θ (C) L   (D) L tan θ (E) $\sqrt{2}$ L

Questions 39–40
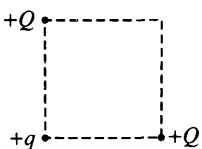
As shown above, two particles, each of charge $+Q$, are fixed at opposite corners of a square that lies in the plane of the page. A positive test charge $+q$ is placed at a third corner.
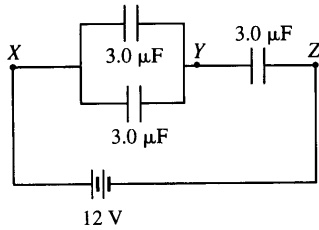
C39. What is the direction of the force on the test charge due to the two other charges?

(A)   (B)   (C)   (D)   (E)

C40. If F is the magnitude of the force on the test charge due to only one of the other charges, what is the magnitude of the net force acting on the test charge due to both of these charges?

(A) Zero   (B) $\dfrac{F}{\sqrt{2}}$ (C) F (D) $\sqrt{2}F$ (E) $2F$
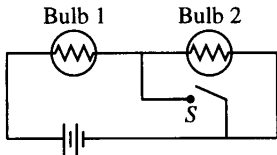
Questions 64–65

Three identical capacitors, each of capacitance 3.0 μF, are connected in a circuit with a 12 V battery as shown above.

C64. The equivalent capacitance between points X and Z is

    (A) 1.0 μF   (B) 2.0 μF   (C) 4.5 μF   (D) 6.0 μF   (E) 9.0 μF

C65. The potential difference between points Y and Z is

(A) zero   (B) 3 V   (C) 4 V   (D) 8 V   (E) 9 V

C66. The circuit in the figure above contains two identical light bulbs in series with a battery. At first both bulbs glow with equal brightness. When switch S is closed, which of the following occurs to the bulbs?

Bulb 1	Bulb 2
(A) Goes out	Gets brighter
(B) Gets brighter	Goes out
(C) Gets brighter	Gets slightly dimmer
(D) Gets slightly dimmer	Gets brighter
(E) Nothing	Goes out
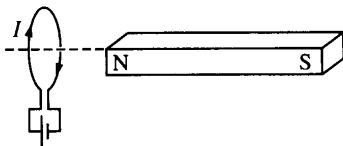
C67. A bar magnet and a wire loop carrying current I are arranged as shown above. In which direction, if any, is the force on the current loop due to the magnet?

    (A) Toward the magnet   (B) Away from the magnet   (C) Toward the top of the page

    (D) Toward the bottom of the page   (E) There is no force on the current loop.

Questions 45–46 refer to two charges located on the line shown in the figure below, in which the charge at point I is $+3q$ and the charge at point III is $+2q$. Point II is halfway between points I and III.
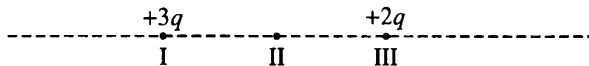

C45. Other than at infinity, the electric field strength is zero at a point on the line in which of the following ranges?

    (A) To the left of I   (B) Between I and II   (C) Between II and III   (D) To the right of III

    (E) None; the field is zero only at infinity.

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C46. The electric potential is negative at some points on the line in which of the following ranges?
    (A) To the left of I   (B) Between I and II   (C) Between II and III   (D) To the right of III
    (E) None; this potential is never negative.

"Reverse" Multiple-Choice Questions

A variation of the standard multiple-choice question asks the student to choose which of five choices is incorrect. Set off by the words NOT or EXCEPT in capital letters, these questions are easy to identify. Examples are:

B35. Quantum concepts are critical in explaining all of the following EXCEPT
    (A) Rutherford's scattering experiments   (B) Bohr's theory of the hydrogen atom
    (C) Compton scattering   (D) the blackbody spectrum   (E) the photoelectric effect
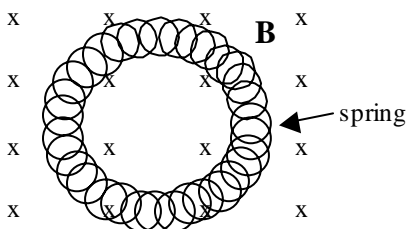
B45. A metal spring has its ends attached so that it forms a circle. It is placed in a uniform magnetic field, as shown above. Which of the following will NOT cause a current to be induced in the spring?
    (A) Changing the magnitude of the magnetic field
    (B) Increasing the diameter of the circle by stretching the spring
    (C) Rotating the spring about a diameter
    (D) Moving the spring parallel to the magnetic field
    (E) Moving the spring in and out of the magnetic field

Section II: Free-Response Questions

Free-response questions are designed to demonstrate multilevel understanding of a concept and ability to reason through a problem. The students need to justify their logic mathematically, graphically, and theoretically. Moreover, they must be able to connect these levels and to communicate their understanding through a well-supported, cohesive series of arguments. They may be asked to demonstrate an understanding of the interrelation between several topic areas. Calculators and a provided formula sheet are allowed on the free-response portions of the B and C exams.

There is no generalized form for free-response questions, and there is no good way to categorize different "types" of questions. However, most of the free-response questions fall into three general groups as follows:
- Numerical questions
- Symbolic questions
- Lab-based questions

Numerical Questions

These questions involve solving a problem to produce a numerical answer.

Partial credit is awarded if part of the answer is correct. Often, students must use answers to one part of a question to solve the next part of the question. Exam Readers take this into account, but students must show all of the steps to receive credit. Making a mathematical error in the first part of a question makes getting numerically accurate answers for the other parts impossible. By showing their equations and reasoning, students can earn points for those subsequent parts.

Merely writing relevant equations is usually insufficient for credit, since the tables of equations are provided.

Here is an example of a computational free-response question:
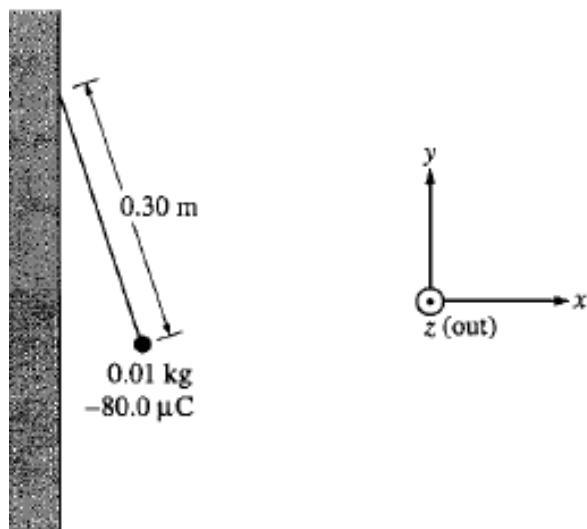
B2. A wall has a negative charge distribution producing a uniform horizontal electric field. A small plastic ball of mass 0.01 kg, carrying a charge of –80.0 μC, is suspended by an uncharged, nonconducting thread 0.30 m long. The thread is attached to the wall and the ball hangs in equilibrium, as shown above, in the electric and gravitational fields. The electric force on the ball has a magnitude of 0.032 N.
a. On the diagram below, draw and label the forces acting on the ball.
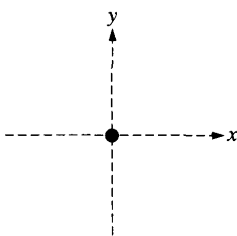
b. Calculate the magnitude of the electric field at the ball's location due to the charged wall, and state its direction relative to the coordinate axes shown.
c. Determine the perpendicular distance from the wall to the center of the ball.
d. The string is now cut.
   i. Calculate the magnitude of the resulting acceleration of the ball, and state its direction relative to the coordinate axes shown.
   ii. Describe the resulting path of the ball.

Symbolic Questions

These involve solving a problem by manipulating variables to give the answer in symbolic form. These questions often indicate which variables may be included in the final answer. Again, it is important that every step be clearly shown. Here is an example:
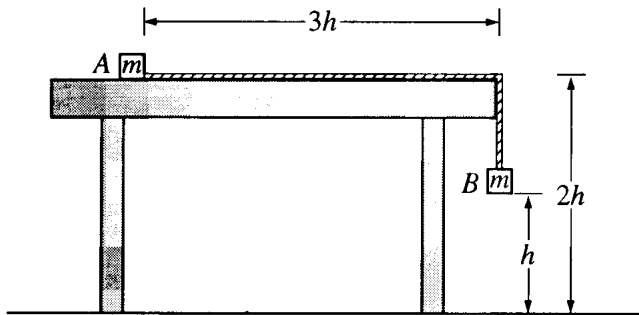
B1. Two small blocks, each of mass m, are connected by a string of constant length $4h$ and negligible mass. Block A is placed on a smooth tabletop as shown above, and block B hangs over the edge of the table. The tabletop is a distance $2h$ above the floor. Block B is then released from rest at a distance h above the floor at time $t = 0$. Express all algebraic answers in terms of h, m, and g.

a. Determine the acceleration of block B as it descends.
b. Block B strikes the floor and does not bounce. Determine the time t_1 at which block B strikes the floor.
c. Describe the motion of block A from time $t = 0$ to the time when block B strikes the floor.
d. Describe the motion of block A from the time block B strikes the floor to the time block A leaves the table.
e. Determine the distance between the landing points of the two blocks.

Lab-Based Questions
These questions may ask students to design an experiment, analyze data, identify sources of error, and/or draw conclusions and suggest ways to improve experiments. The best way to prepare students for this type of question is to conduct meaningful laboratory work throughout the course.

This an example of a lab-based question:
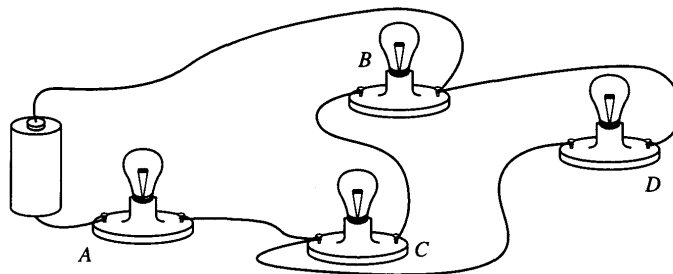
B4. In the circuit shown above, *A*, *B*, *C*, and *D* are identical light bulbs. Assume that the battery maintains a constant potential difference between its terminals (i.e., the internal resistance of the battery is assumed to be negligible) and the resistance of each lightbulb remains constant.

a. Draw a diagram of the circuit in the box below, using the following symbols to represent the components in your diagram. Label the resistors *A*, *B*, *C*, and *D* to refer to the corresponding lightbulbs.

Battery   Resistors
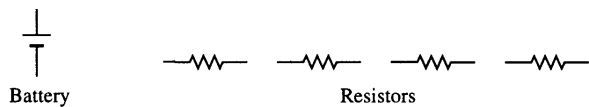
Draw your diagram in this box only.

b. List the bulbs in order of their brightness, from brightest to least bright. If any two or more bulbs have the same brightness, state which ones. Justify your answer.
c. Bulb *D* is then removed from its socket.
   i. Describe the change in the brightness, if any, of bulb *A* when bulb *D* is removed from its socket. Justify your answer.
   ii. Describe the change in the brightness, if any, of bulb *B* when bulb *D* is removed from its socket. Justify your answer.

Directive Words and Phrases

Students should pay special attention to directive words and phrases when reading the questions and only provide the information required by these terms:

"Justify" and "explain" call for an answer supported by prose, equations, calculations, diagrams, or graphs. The prose or equations may refer to fundamental ideas or relations in physics, such as Newton's laws, conservation of energy, Gauss's law, or Bernoulli's equation. In other cases, the justification or explanation may take the form of analyzing the behavior of an equation for large or small values of a variable in the equation.

"Calculate" means that students are expected to show work leading to a final answer, which may be algebraic, but which is more often numerical.

"What is" and "determine" indicate that students do not need to show their work to obtain full credit. But showing work leading to answers is a good idea because partial credit can be earned in the case of an incorrect answer.

"Derive" is more specific and indicates that students need to begin their solution with one or more fundamental equations, such as those given on the AP Physics Exam equation sheet. They can then obtain the final answer, usually algebraic, through the appropriate use of mathematics.

II. Exam-Taking Strategies

You can find the following suggestions for exam preparation on my Web site:

> Preparing for the Exam
> http://apphysicsb.homestead.com/prep.html
> - Study skills
> - Strategies for the multiple-choice section
> - Strategies for the free-response section

The following are tips and strategies for students taking the AP Physics B Exam by Hugh Henderson:

1. The AP Physics B Exam is structured like this:
  (a) The multiple-choice section contains 70 questions in 90 minutes. Each question is worth 1.286 points (that is, 90/70). They usually start with kinematics and dynamics questions but are more or less random in content after that.
  (b) The free-response section contains six or seven questions in 90 minutes, some of which are worth 10 points and others 15 points.
  (c) The exam is designed to score 1 point per minute on average. Thus, you should plan on spending on average a little over a minute on each multiple-choice question, 10 minutes on a

10-point problem, and 15 minutes on a 15-point problem.

(d) While the exact scoring varies from year to year, if you can average a raw score of about 60 percent on the multiple-choice and free-response sections of the exam, you're on track to earn a 5 on the exam. A raw score of about 45 percent may earn a 4, and 30 percent or so may earn a 3.

2. Read through all of the multiple-choice questions first, answering the ones you can quickly answer first, skipping those you need to come back to. Then go back and work out the questions that are more difficult for you.

3. There is a penalty for random guessing, so if you can narrow the answer to a question to three reasonable choices (that is, eliminating at least two answers), then go ahead and guess. If you have no idea what the question is asking for, skip it quickly.

4. As a general rule, don't skip more than about 10 questions out of 70.

5. Eliminate answers that contain equations in which the units are not correct (like $F = mv^2$). If the question is asking for force, for example, and the equation in the answer gives you units for energy, you can eliminate that answer.

6. If two answers are close in wording but contain opposite ideas, there is a reasonable chance that one of them is correct. By the same token, if two answers mean basically the same thing, they cannot both be correct, and you can eliminate them.

7. Predict the answer before reading the answer choices so you aren't tempted by wrong answers.

8. On the free-response section of the exam, read all of the questions and work the ones you're most comfortable with first. The first question on the exam may not be the easiest one.

9. Show enough work on each part to earn partial credit if you get the answer wrong. Even if a question calls for a one-word answer (like yes or no), write a few words about how you arrived at the answer. For example, "The current is clockwise by Lenz's law" instead of just "clockwise" may get one extra point if "clockwise" is the wrong answer.

10. If you're not sure how to answer part of a free-response question, at least write down a law or equation that you know is relevant (like "conservation of energy" or "$F_{net} = ma$"). Sometimes you'll be given a point or two just for stating a relevant law.

11. If you don't know how to work part (a) in a problem but need the answer to part (a) in part (b), make up an answer to part (a) and use it consistently throughout the rest of the problem. You will be given full credit for later parts even though part (a) is not correct.

12. Your goal throughout the exam should be to earn points, so don't worry about how many points you are losing. You don't have to ace the exam to get a good score, because the grades are curved. Try not to get frustrated or discouraged while taking the exam. Thousands of students around the world are frustrated and discouraged on exam day, and it's very likely that you are doing much better than you think you are.

13. For numerical answers, be sure to include proper units and use a reasonable number of significant digits.

III. Exam Preparation

Review Approaches

Cumulative review:
This type of review takes place throughout the year.
- It consists of including questions from past topics in unit tests. For example, in the electromagnetic induction test, you can include energy and work questions.
- Students can review by studying these tests.

End-of-year review:
- This type of review uses previous tests as the central focus of the review.
- The students have assigned questions and problems as homework.
- The following day while going over the assignment, the students will have an opportunity to identify problem-solving strategies.

Ideas for the end-of-the-year review:
A. If time allows, set two weeks prior to the exam for reviewing.
- Prepare a timetable that includes the topics and the chapter pages from the textbook.
- Tell students they are responsible for reading and studying the material.
- During class, give a 10-question, multiple-choice quiz and two to three free-response questions.
- By the end of the review period, it is important to set up a mock examination in real time.

The following page includes a review timetable for the AP Physics B Exam in a course that uses Giancoli's *Physics*, 5th ed.

B. If time is an issue, you can assign questions as homework on a daily basis.
- Divide the topics into 15 sections so your review can start three weeks before the exam date. Expect your students to work on 5-10 multiple-choice questions and 2-4 free-response questions per night.
- Using the timetable, begin your review nine days before the exam date.

A list of multiple-choice and free-response questions divided by content (1988–2003) is included after the timetable.

AP REVIEW GUIDE	TEXTBOOK	SCHEDULE
1 Introduction	Chapter 1	Day 1
2 Kinematics in One Dimension	Chapter 2	Day 1
3 Kinematics in Two Dimensions	Chapter 3	Day 1
4 Forces and Newton's Laws of Motion	Chapter 4	Day 2
5 Dynamics of Uniform Circular Motion	Chapter 5	Day 2
6 Work and Energy	Chapter 6	Day 3
7 Impulse and Momentum	Chapter 7	Day 3
8 Rotational Equilibrium: Torque	Chapters 8/9	Day 3
10 Simple Harmonic Motion and Elasticity	Chapter 11	Day 4
16 Waves and Sound	Chapter 11	Day 4
11 Fluids	Chapter 10	Day 5
14 The Ideal Gas Law and Kinetic Theory	Chapter 13	Day 5
15 Thermodynamics	Chapter 15	Day 5
18 Electric Forces and Electric Fields	Chapter 16	Day 6
19 Electric Potential Energy and Potential	Chapter 17	Day 6
20 Electric Circuits	Chapters 18/19	Day 6
21 Magnetic Forces and Magnetic Fields	Chapter 20	Day 7
22 Electromagnetic Induction	Chapter 21	Day 7
25 The Reflection of Light: Mirrors	Chapters 22/23	Day 8
26 The Refraction of Light: Lenses	Chapter 23	Day 8
27 The Wave Nature of Light	Chapter 24	Day 8
29 Particles and Waves	Chapter 27	Day 9
30 The Nature of the Atom	Chapter 30	Day 9
31 Nuclear Physics and Radioactivity	Chapter 31	Day 9

On Day 10 a full AP Physics Exam is administered.

AP Physics B Content Outline with Historical Problems 1980–2003

Compiled by Gardner Friedlander
   Kinematics and dynamics
   84MC5,6,7,8,9,11,51,61,67; 88MC1,4,5,9,18,42,58,62,63; 93MC1,2,3,5,45,61,61,64,65,66;
   98MC7,44,59
   82B1,82B2,85B2abc,86B1,87B1,88B1,92B1,95B3abcd,97B2,98B1,98B6,00B1exc.e(iii),00
   B2,03B1,03bB1

   Energy and momentum
84MC2, 10,52,56; 88MC3,6,7,10,51,52; 93MC4,7,10,11,44,47,62; 98MC1,2,3,4,5,9,41,43,57,60,63,67
80B5a,81B1,81B2,84B2,85B1,85B2,86B2,88B2ab,90B1,91B1,92B1,96B1,99B1exc.a,01B2,02B1,
02bB1

   Circular motion and torque
84MC8,13,51,67; 88MC2,3,43,60; 93MC12,46,57; 98MC6,58,68
80B1,82B3,83B1c,84B1,89B1,91B1,95B3,97B2,98B6,99B5,01B1,02bB2

Gravitation and orbits
84MC9,14,56,66; 88MC13,61; 93MC6,8,48; 98MC39,40 99B1a

SHM
84MC4,12; 88MC8,11,12,44,69; 93MC9,43; 98MC8,38,56; 83B2,02B2

Fluids: New in 2002
02B6, 03B6, 03bB6

Heat and thermodynamics**
84MC30*,31,32,33,34,50, 88MC19,22,23,24,25,26,48,49,50,70; 93MC23; 98MC22,23,24,52,53
83B4,86B5,,89B4,,96B7,99B7,,01B6, 03B5, 03bB5

Light and geometrical optics
84MC36,37,38,69; 88MC29,31,33,55; 93MC26,31,69; 98MC26,27,28,30,31,42,50
80B4e,81B5,82B6,83B5,86B6,87B5,89B6,92B5,93B4,94B6,97B5,99B6a,00B4a,01B4,02B4,02bB4,03B4,03bB3

Waves (general, sound, standing waves) and physical optics
84MC13,39,90; 88MC27,28,30,32; 93MC27,28,30,52,58,59,60; 98MC29,49,51
80B4abcd,84B5,88B5,90B6,91B6ab,96B3,98B7ac,99B6b,00B4b

Electrostatics, capacitance
84MC15,16,17,19,20,24,25,54,59; 88MC14,16,17,20,54,57,59; 93MC17,68,70; 98MC13,14,17,18,64,70
80B5bc,81B3,83B3,85B3,87B2,88B3,89B2,90B2abcd,98B2,99B2,00B3,01B3,02bB3,02bB5,03bB4

Circuits and resistance
84MC18,22,23,26,27,28,57,62,64; 88MC15,40,68; 93MC13,14,15,16,20,21,22,50,51; 98MC15,16,20,65
80B2,81B4,82B4,86B3,87B4,89B3,90B3,91B4,92B3,95B2,96B4,97B4,98B4,01B5,02B3,03B2,03bB2

Magnetism
84MC21,60,63; 88MC47; 93MC18,19; 98MC19,21,46,47
84B4,88B4,91B2,92B5,93B3,94B4,95B7,97B3,98B8;00B7,02B5,03B3

Induced EMF
84MC29,53; 88MC21,41,53; 93MC41,67; 98MC45,48,66
82B5,86B4,94B6,99B3

Atomic and wave/particle physics*
84MC15,41,42,43,46,58,70; 88MC33,36,67; 93MC29,34,35,37,38,53; 98MC10,11,34,35,37,54,55,69
80B3,82B7,83B6,85B687B6,88B6,90B5,91B6,92B4,93B6,95B4,96B6,97B6,98B7,00B5,02B7,02bB7,03B7,03bB7

Nuclear Physics*
84MC44,45; 88MC34,39,45,46,56,64,66; 93MC32,33,42,54; 98MC12,33
80B5d,81B6,89B5,91B5,96B5,99B4,01B7

* This topic reduced in scope and emphasis starting in 2002.

** This topic reduced in scope and emphasis starting in 2004.

The topics of specific heat, latent heat, half-life, and relativity (other than $E = mc^2$) have been eliminated, and those questions do not appear in the above list.

IV. Exam Preparation Resources

Multiple-Choice Questions
- Textbooks' test-item resources
- Textbook companion Web sites with interactive problems
    http://apphysicsb.homestead.com/ips.html
- Physics Bowl past examinations
    www.compadre.org/psrc/evals/physicsbowl.cfm
- Regents past examinations
    www.nysedregents.org/testing/scire/regentphys.html

Free-Response Questions
There is no substitute for free-response questions from past examinations.

Free-response questions from 1999-2004 are available at AP Central. Included with the questions are scoring guidelines, sample student responses, commentary on those responses, as well as exam statistics and the Student Performance Q&A for past administrations.

Released exams are available in the College Board store for 1998 and 2004.

Test-Prep Books
Book and software reviews are available in the Teachers' Resources section on AP Central.

Hugh Henderson:
AP Physics B: An Apex Learning Guide
AP Physics B: Student Study Guide

Jim Mooney:
AP Advantage: Physics C
AP Advantage: Physics B

Jonathan Wolf:
Barron's *How to Prepare for the AP Physics B Exam,* 2e.
 PhysicsTutor: Excalibur Edition

Other Resources

- **Preparing for the exam**
http://apphysicsb.homestead.com/review.html
AP Physics review sessions
Exam preparation strategies

- **Physics conceptual facts**
http://apphysicsb.homestead.com/physicsfacts.html
A list of 100-plus facts and important physics concepts

- **Open-ended labs**
http://apphysicsb.homestead.com/labsoe.html
Free-response lab ideas compiled by Hugh Henderson

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