



# Practice Test 1

# AP<sup>®</sup> Physics 1 Exam

## SECTION I: Multiple-Choice Questions

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.**

### At a Glance

**Total Time**

90 minutes

**Number of Questions**

50

**Percent of Total Grade**

50%

**Writing Instrument**

Pen required

### Instructions

Section I of this examination contains 50 multiple-choice questions. Fill in only the ovals for numbers 1 through 50 on your answer sheet.

**CALCULATORS MAY BE USED ON BOTH SECTIONS OF THE AP PHYSICS 1 EXAM.**

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. Please note that there are two types of multiple-choice questions: single-select and multi-select questions. After you have decided which of the suggested answers is best, completely fill in the corresponding oval(s) on the answer sheet. For single-select, you must give only one answer; for multi-select you must give BOTH answers in order to earn credit. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

Sample QuestionSample Answer

Chicago is a

- (A) state
- (B) city
- (C) country
- (D) continent

(A) ● (C) (D)

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all the multiple-choice questions.

### About Guessing

Many candidates wonder whether or not to guess the answers to questions about which they are not certain. Multiple-choice scores are based on the number of questions answered correctly. Points are not deducted for incorrect answers, and no points are awarded for unanswered questions. Because points are not deducted for incorrect answers, you are encouraged to answer all multiple-choice questions. On any questions you do not know the answer to, you should eliminate as many choices as you can, and then select the best answer among the remaining choices.

**GO ON TO THE NEXT PAGE.**

## ADVANCED PLACEMENT PHYSICS 1 EQUATIONS, EFFECTIVE 2015

CONSTANTS AND CONVERSION FACTORS	
Proton mass, $m_p = 1.67 \times 10^{-27}$ kg	Electron charge magnitude, $e = 1.60 \times 10^{-19}$ C
Neutron mass, $m_n = 1.67 \times 10^{-27}$ kg	Coulomb's law constant, $k = 1/4\pi\epsilon_0 = 9.0 \times 10^9$ N·m <sup>2</sup> /C <sup>2</sup>
Electron mass, $m_e = 9.11 \times 10^{-31}$ kg	Universal gravitational constant, $G = 6.67 \times 10^{-11}$ m <sup>3</sup> /kg·s <sup>2</sup>
Speed of light, $c = 3.00 \times 10^8$ m/s	Acceleration due to gravity at Earth's surface, $g = 9.8$ m/s <sup>2</sup>

UNIT SYMBOLS	meter, m	kelvin, K	watt, W	degree Celsius, °C
	kilogram, kg	hertz, Hz	coulomb, C	
	second, s	newton, N	volt, V	
	ampere, A	joule, J	ohm, Ω	

PREFIXES		
Factor	Prefix	Symbol
$10^{12}$	tera	T
$10^9$	giga	G
$10^6$	mega	M
$10^3$	kilo	k
$10^{-2}$	centi	c
$10^{-3}$	milli	m
$10^{-6}$	micro	μ
$10^{-9}$	nano	n
$10^{-12}$	pico	p

VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES							
$\theta$	0°	30°	37°	45°	53°	60°	90°
$\sin \theta$	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
$\cos \theta$	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0
$\tan \theta$	0	$\sqrt{3}/3$	3/4	1	4/3	$\sqrt{3}$	∞

The following conventions are used in this exam.

- I. The frame of reference of any problem is assumed to be inertial unless otherwise stated.
- II. Assume air resistance is negligible unless otherwise stated.
- III. In all situations, positive work is defined as work done on a system.
- IV. The direction of current is conventional current: the direction in which positive charge would drift.
- V. Assume all batteries and meters are ideal unless otherwise stated.

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## AP PHYSICS 1

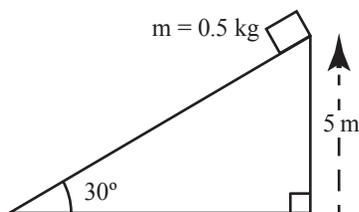
## SECTION I

Note: To simplify calculations, you may use  $g = 10 \text{ m/s}^2$  in all problems.

**Directions:** Each of the questions or incomplete statements is followed by four suggested answers or completions. Select the one that is best in each case and then fill in the corresponding circle on the answer sheet.

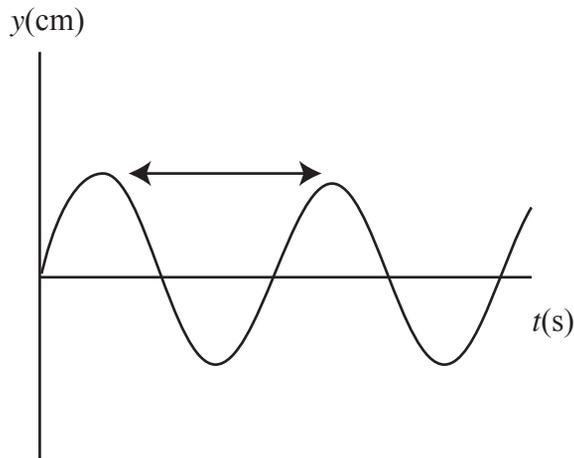
- What happens to the force of gravitational attraction between two small objects if the mass of each object is doubled and the distance between their centers is doubled?
  - It is doubled.
  - It is quadrupled.
  - It is halved.
  - It remains the same.
- If the coefficient of friction between the block and the incline is 0.4, how much work is done by the normal force on the block as it slides down the full length of the incline?
  - 0 J
  - 2.0 J
  - 4.0 J
  - 4.9 J

Questions 2-4 refer to the following figure:

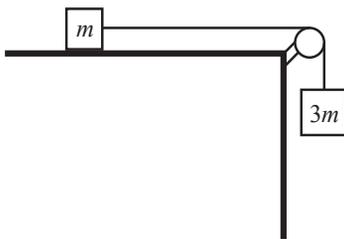


- If the surface of the incline is frictionless, how long will the block take to reach the bottom if it was released from rest at the top?
  - 0.5 s
  - 1.0 s
  - 1.4 s
  - 2.0 s
- If the surface of the incline is frictionless, with what speed will the block reach the bottom if it was released from rest at the top?
  - 8 m/s
  - 10 m/s
  - 14 m/s
  - 18 m/s
- Two satellites are in circular orbit around the Earth. The distance from Satellite 1 to Earth's center is  $r_1$ , and the distance from Satellite 2 to the Earth's center is  $r_2$ , what is the speed of Satellite 2?
  - $v_1 \sqrt{r_2/r_1}$
  - $v_1 \sqrt{r_1/r_2}$
  - $v_1 \left( \frac{r_2}{r_1} \right)$
  - $v_1 \left( \frac{r_1}{r_2} \right)^2$

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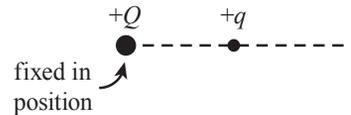


6. The graph above shows a wave. What quantity of the wave does the indicated segment represent?
- (A) Frequency  
 (B) Wavelength  
 (C) Period  
 (D) Cannot be determined
7. Sound waves travel at 350 m/s through warm air and at 3,500 m/s through brass. What happens to the wavelength of a 700 Hz acoustic wave as it enters brass from warm air?
- (A) It decreases by a factor of 20.  
 (B) It decreases by a factor of 10.  
 (C) It increases by a factor of 10.  
 (D) The wavelength remains unchanged.

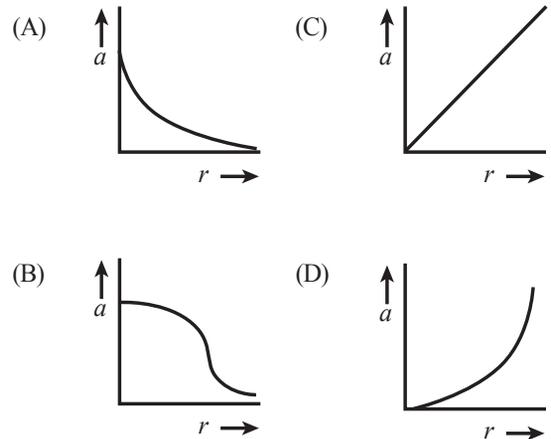


8. In the figure above, the coefficient of sliding friction between the small block and the tabletop is 0.2. If the pulley is frictionless and massless, what will be the acceleration of the blocks once they are released from rest?
- (A)  $0.5g$   
 (B)  $0.6g$   
 (C)  $0.7g$   
 (D)  $0.8g$

9. Two people, one of mass 100 kg and the other of mass 50 kg, stand facing each other on an ice-covered (essentially frictionless) pond. If the heavier person pushes on the lighter one with a force  $\mathbf{F}$ , then
- (A) the force felt by the heavier person is  $(-1/2)\mathbf{F}$   
 (B) the force felt by the person is  $-2\mathbf{F}$   
 (C) the magnitude of the acceleration of the lighter person will be half of the magnitude of the acceleration of the heavier person  
 (D) the magnitude of the acceleration of the lighter person will be twice the magnitude of the acceleration of the heavier person

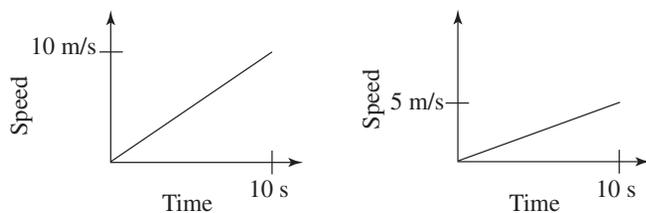


10. The figure above shows two positively charged particles. The  $+Q$  charge is fixed in position, and the  $+q$  charge is brought close to  $+Q$  and released from rest. Which of the following graphs best depicts the acceleration of the  $+q$  charge as a function of its distance  $r$  from  $+Q$ ?

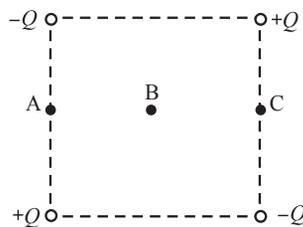


11. A horizontal spring-block oscillator is in motion when a second block of equal mass falls on top of the oscillating block. If the two blocks stick together, what effect will this have on the amplitude of the oscillations?
- (A) It will increase the amplitude.  
 (B) It will decrease the amplitude.  
 (C) It will have no effect.  
 (D) It would depend on where the original block was in its cycle when the second block fell.

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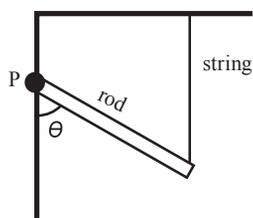


12. The graphs above show the changes in speed for two different blocks. The left graph shows the speed over time of Block 1, which has a mass of  $m_1$ , and the right graph shows the speed of Block 2, which has a mass of  $2m_1$ . While speeding up, they both had to overcome some frictional force,  $f$ . Which of the two blocks had more power provided to it?
- (A) Block 1  
 (B) Block 2  
 (C) They had equal power provided.  
 (D) It depends on the ratio of  $m/f$ .
13. If the force of gravity between the Moon and the Earth were to stop, which statement best describes the resulting motion of the moon?
- (A) It would continue rotating on its axis, and it would revolve around the Earth as usual.  
 (B) It would continue rotating on its axis, but it would stop revolving around the Earth.  
 (C) It would stop rotating on its axis, but it would revolve around the Earth as usual.  
 (D) It would stop rotating on its axis, and it would stop revolving around the Earth.
14. The weight of a box on the Earth is 80 N. What is the weight of the box on the moon if the moon has  $1/80$ th the mass and  $1/4$ th the radius of the Earth?
- (A) 1 N  
 (B) 10 N  
 (C) 16 N  
 (D) 20 N
15. A ball of mass is attached to a string connected to the ceiling, forming a pendulum. When the string is raised to an angle of 50 degrees below the horizontal (the ceiling) and released, the ball swings back and forth with a period of 0.4 s. Which of the following changes to the pendulum would decrease the period of the pendulum?
- (A) Increasing the mass of the ball  
 (B) Decreasing the length of the string  
 (C) Decreasing the angle of the string from the horizontal when released  
 (D) Decreasing the mass of the ball
16. Three light bulbs, each with a resistance of  $R$ , are connected in parallel to a battery in a simple circuit. If the middle bulb goes out, then
- (A) the other bulbs will also go out.  
 (B) the bulbs will stay on, and the current will increase.  
 (C) the bulbs will stay on, and the current will remain the same.  
 (D) the bulbs will stay on, and the current will decrease.

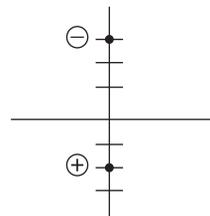


17. The figure above shows a plane diagram. The figure shows four point charges arranged at the corners of a square with point B as its center. A positive charge would experience no net force if it were placed at which of the three points shown in the figure?
- (A) A only  
 (B) B only  
 (C) C only  
 (D) A, B, or C
18. A beam of monochromatic light entering a glass window pane from the air will experience a change in
- (A) frequency and wavelength  
 (B) frequency and speed  
 (C) speed and wavelength  
 (D) speed only

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19. If the rod in the figure above is uniform and has mass  $m$ , what is the tension in the supporting string? The rod is free to rotate about point P.
- (A)  $\frac{1}{2}mg \sin \theta$   
 (B)  $mg \sin \theta$   
 (C)  $\frac{1}{2}mg \cos \theta$   
 (D)  $\frac{1}{2}mg$
20. An ideal battery of constant voltage  $V$  supplies current to a circuit that has total resistance  $R$ . If  $R$  is doubled, what will happen to the total power dissipated by the circuit?
- (A) It will double.  
 (B) It will quadruple.  
 (C) It will be halved.  
 (D) It will remain the same.
21. Two spheres of net charge  $+5e$  and  $-6e$  briefly come into contact. Afterward, which of the following is a possible combination of net charges for the two spheres?
- (A)  $+3e$  and  $-4e$   
 (B)  $+1.5e$  and  $-2.5e$   
 (C) Both of the above  
 (D) None of the above
22. In which of the following situations involving a source of sound and a detector of the sound is it possible that there is NO perceived Doppler shift?
- (A) The source travels toward the stationary detector.  
 (B) The detector travels toward the stationary source.  
 (C) Both the source and detector travel in the same direction.  
 (D) Both the source and detector travel in opposite directions, with the source and detector moving away from each other.
23. If  $L$ ,  $M$ , and  $T$  denote the dimensions of length, mass, and time, respectively, what are the dimensions of power?
- (A)  $L^2M/T^2$   
 (B)  $M^2L/T^2$   
 (C)  $L^2M/T^3$   
 (D)  $ML^2/T^3$
24. An object (mass =  $m$ ) above the surface of the Moon (mass =  $M$ ) is dropped from an altitude  $h$  equal to the Moon's radius ( $R$ ). What is the object's impact speed?
- (A)  $\sqrt{GM/R}$   
 (B)  $\sqrt{GM/(2R)}$   
 (C)  $\sqrt{2GM/R}$   
 (D)  $\sqrt{2GMm/R}$
25. When turning a corner on a bicycle, the rider leans into the turn. The frame of the bike is nearly parallel to which vector?
- (A) The force of gravity on the bicycle and rider  
 (B) The centripetal force  
 (C) The normal force  
 (D) The sum of the normal and frictional forces



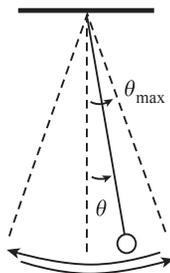
26. In the diagram above, a positive charge and negative charge are placed at  $y = -2$  and  $y = 3$ , respectively. If the negative charge has a greater magnitude, then the only place of 0 net electric field would be
- (A) Along the positive  $x$ -axis  
 (B) Along the negative  $x$ -axis  
 (C) Along the positive  $y$ -axis  
 (D) Along the negative  $y$ -axis

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27. A projectile is launched with an initial velocity of magnitude  $a$  at an angle  $\beta$  to the horizontal. Find its maximum vertical displacement, ignoring effects due to the air.

(A)  $(a^2 \sin 2\beta)/(2g)$   
 (B)  $(a^2 \sin^2 \beta)/(2g)$   
 (C)  $(a^2 \sin 2\beta)/g$   
 (D)  $(a^2 \sin^2 \beta)/g$



28. A simple pendulum executes simple harmonic motion as it swings through small angles of oscillation. If  $\theta_{\max}$  denotes the amplitude of the oscillations, which of the following statements is true?
- (A) When  $\theta = 0$ , the tangential acceleration is 0.  
 (B) When  $\theta = \theta_{\max}$ , the tangential acceleration is 0.  
 (C) When  $\theta = 0$ , the speed is 0.  
 (D) When  $\theta = 0$ , the restoring force is maximized.
29. A wire is split into 4 segments, and they have resistances of  $R$ ,  $2R$ ,  $\frac{1}{2}R$ , and  $4R$  in that order. Which of the following sets of changes from one segment to the next could correctly account for the changes in resistance?

$R \rightarrow 2R$

$2R \rightarrow 4R$

$4R \rightarrow R$

- |                       |                 |                      |
|-----------------------|-----------------|----------------------|
| (A) length is doubled | area is doubled | radius is doubled    |
| (B) length is doubled | area is halved  | radius is doubled    |
| (C) length is doubled | area is doubled | radius is quadrupled |
| (D) length is halved  | area is doubled | radius is doubled    |

30. Two traveling waves of equal frequency, one of amplitude 4 cm and the other of amplitude 6 cm, superimpose in a single medium. Which of the following best describes the displacement,  $D$ , of the resultant wave?

(A)  $2 \text{ cm} \leq D \leq 10 \text{ cm}$   
 (B)  $D = 5 \text{ cm}$   
 (C)  $D = 10 \text{ cm}$   
 (D)  $10 \text{ cm} \leq D \leq 12 \text{ cm}$

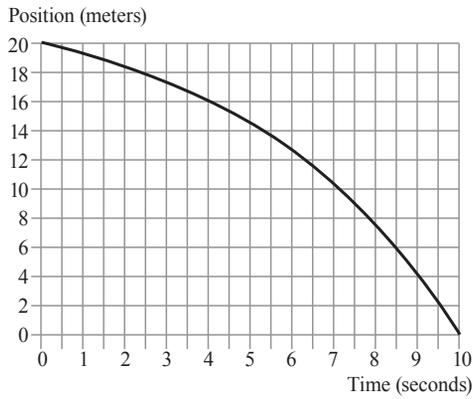
31. A uniform bar is lying on a flat table. Besides the gravitational and normal forces (which cancel), the bar is acted upon by two other forces,  $\mathbf{F}_1$  and  $\mathbf{F}_2$ , which are parallel to the surface of the table. If the net force on the rod is zero, then which one of the following is true?

(A) The net torque on the bar must also be zero.  
 (B) The bar can accelerate translationally if  $\mathbf{F}_1$  and  $\mathbf{F}_2$  are not applied at the same point.  
 (C) The net torque will be zero if  $\mathbf{F}_1$  and  $\mathbf{F}_2$  are applied at the same point.  
 (D) The bar cannot accelerate translationally or rotationally.

32. An elevator is rising. In order to determine the tension in the cables pulling it, which values (for the elevator) would you need to know?

(A) Mass, velocity, height, and acceleration  
 (B) Mass, velocity, and acceleration  
 (C) Mass and velocity  
 (D) Mass and acceleration

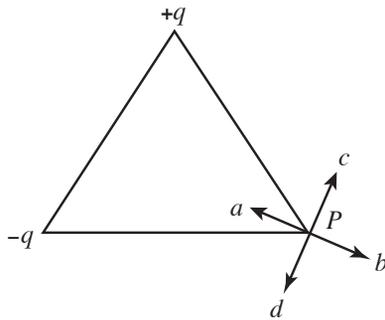
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33. In the graph above, the instantaneous velocity at 9 seconds is closest to

- (A)  $\frac{4}{9}$  m/s  
 (B)  $-\frac{4}{9}$  m/s  
 (C)  $\frac{11}{4}$  m/s  
 (D)  $-\frac{11}{4}$  m/s

Questions 34-35 refer to the following figure:

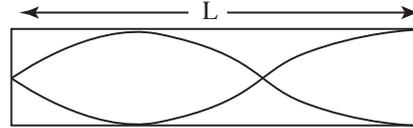


34. Two charges are placed as shown at the vertices of an equilateral triangle. What is the direction of the electric field at point  $P$ ?

- (A)  $a$   
 (B)  $b$   
 (C)  $c$   
 (D)  $d$

35. If a charge of  $+q$  is placed at point  $P$ , the electric field at point  $P$  would

- (A) increase by  $\frac{1}{3}$   
 (B) increase by  $\frac{1}{2}$   
 (C) decrease by  $\frac{1}{3}$   
 (D) remain the same



36. A tube with one end closed and one end open resonates for a wave with wavelength  $\lambda_a$  as shown. The next shorter wavelength at which resonance will occur is  $\lambda_b$ . The ratio of these two wavelengths  $\lambda_a/\lambda_b$  is

- (A)  $\frac{1}{4}$   
 (B)  $\frac{1}{3}$   
 (C)  $\frac{3}{5}$   
 (D)  $\frac{5}{3}$

37. A projectile of mass  $m$  is fired into the air at some angle  $\theta$ . If its launch velocity is  $v_0$ , which of the following expressions represents the object's kinetic energy at the peak of its motion?

- (A) 0  
 (B)  $(1/2)m(v_0 \sin \theta)^2$   
 (C)  $(1/2)m(v_0 \cos \theta)^2$   
 (D)  $(1/2)m[(v_0 \sin \theta)^2 + (v_0 \cos \theta)^2]$

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38. A man stands in an elevator as it begins to ascend. Does the normal force from the floor do work on the man?
- (A) Yes, and the work done will be positive.  
 (B) Yes, and the work done will be negative.  
 (C) Yes, but the sign can't be determined.  
 (D) No.
39. An alarm whose frequency is 400 Hz is dropped out of a third-floor window. The student who drops it measures the frequency with a very sensitive oscilloscope. The measured frequency
- (A) appears higher than 400 Hz and the frequency increase as it falls  
 (B) appears higher than 400 Hz and the frequency decreases as it falls  
 (C) appears lower than 400 Hz and the frequency decreases as it falls  
 (D) appears lower than 400 Hz and the frequency increases as it falls
40. A small cart of mass  $M$  is initially at rest. It collides elastically with a large cart of mass  $4M$  and velocity  $v$ . The large cart loses half its kinetic energy to the little cart. The little cart now has a velocity of
- (A)  $1.41v$   
 (B)  $v$   
 (C)  $2v$   
 (D)  $4v$
41. What is the power developed by the force?
- (A)  $FR$   
 (B)  $Fv$   
 (C)  $Mv^2$   
 (D)  $0$
42. Two objects, A and B, have equal charge and equal mass. Neither body is in motion because the gravitational and electrostatic forces between them are equal. If the mass of Object A is halved, equilibrium will be maintained if
- (A) the charge on Object A were doubled  
 (B) the charge on Object B were halved  
 (C) the charge on Object B were doubled  
 (D) the mass on Object B were halved
43. Which configuration of battery and resistors will create a circuit with the greatest current?
- (A) A high voltage battery with resistors arranged in series  
 (B) A high voltage battery with resistors arranged in parallel  
 (C) A low voltage battery with resistors arranged in series  
 (D) A low voltage battery with resistors arranged in parallel
44. Which of the following changes to a circuit will always bring about an increase in the current?
- (A) Increased voltage and increased resistance  
 (B) Decreased voltage and decreased resistance  
 (C) Increased voltage and decreased resistance  
 (D) Decreased voltage and increased resistance

Questions 41-42 refer to the following setup.

A stopper of mass  $M$  is tied to a string of length  $R$  and swings around horizontally in uniform circular motion with a velocity of  $v$  when acted on by a force of  $F$ .

41. What is the period of the stopper?

- (A)  $\sqrt{\frac{4\pi^2 MR}{F}}$   
 (B)  $\sqrt{\frac{MR}{4\pi^2 F}}$   
 (C)  $\sqrt{\frac{4\pi^2}{FMR}}$   
 (D)  $\sqrt{\frac{4\pi^2 R}{MF}}$

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**Directions:** For each of the questions 46-50, two of the suggested answers will be correct. Select the two answers that are best in each case, and then fill in both of the corresponding circles on the answer sheet.

46. If the acceleration of an object is not zero, then which of the following could be constant? Select two answers.
- (A) Speed
  - (B) Linear momentum
  - (C) Kinetic energy
  - (D) Velocity
47. A lightweight toy car crashes head-on into a heavier toy truck. Which of the following statements is true as a result of the collision? Select two answers.
- (A) The car will experience a greater impulse than the truck.
  - (B) The car will experience a greater change in momentum than the truck.
  - (C) The magnitude of the acceleration experienced by the car will be greater than that experienced by the truck.
  - (D) The total momentum in the collision will be conserved.
48. A student has two tuning forks, one with a frequency of  $f_1 = 50$  Hz and the other  $f_2 = 55$  Hz. When both tuning forks are struck, a beat frequency is generated. Which of the following manipulations could lead to an increase in the beat frequency? Select two answers.
- (A) Increasing the frequency of the 50 Hz tuning fork
  - (B) Increasing the frequency of the 55 Hz tuning fork
  - (C) Decreasing the frequency of the 50 Hz tuning fork
  - (D) Decreasing the frequency of the 55 Hz tuning fork
49. A mass on a spring and a simple pendulum undergo simple harmonic motion. There is no friction present for the mass on the string. Which of the following statements are true? Select two answers.
- (A) Mechanical energy is constant.
  - (B) The momentum of the mass is constant.
  - (C) The period of the mass is constant.
  - (D) The restoring force is constant.
50. The electric field strength in a vacuum at a point at a distance from a source charge is NOT dependent on which of the following? Select two answers.
- (A) Another charge placed at that point
  - (B) The magnitude of the source charge
  - (C) The distance from the source charge
  - (D) The sign of the source charge

**END OF SECTION I**  
**DO NOT CONTINUE UNTIL INSTRUCTED TO DO SO.**

AP PHYSICS 1

SECTION II

Free-Response Questions

Time—90 minutes

Percent of total grade—50

5 Questions

General Instructions

Use a separate piece of paper to answer these questions. Show your work. Be sure to write CLEARLY and LEGIBLY. If you make an error, you may save time by crossing it out rather than trying to erase it.

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## AP PHYSICS 1

## SECTION II

**Directions:** Question 1, 2, and 3 are short free-response questions that require about 13 minutes to answer and are worth 8 points each. Questions 4 and 5 are long free-response questions that require about 25 minutes each to answer and are worth 13 points each. Show your work for each part in the space provided after that part.

1. In a physics experiment, a pellet of mass 2 kg is fired from an air gun horizontally toward a block of mass 18 kg attached to a string on the ceiling. When the pellet strikes the block, it becomes embedded and the pellet-block system reaches a maximum height of 0.2 m.

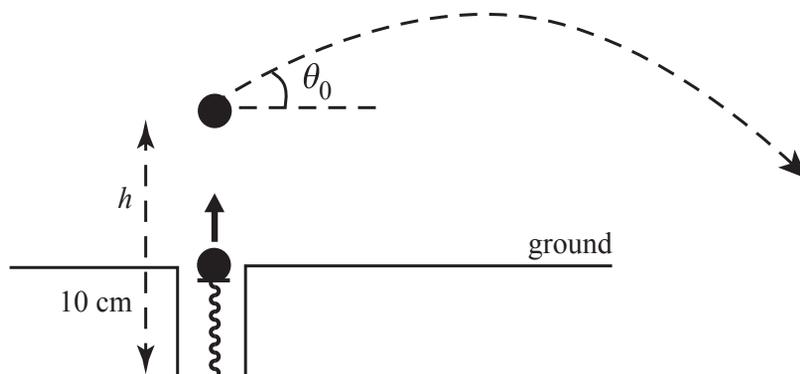


- (a) What is the total energy of the system when the pellet-block system reaches its maximum height?
- (b) What is the speed of the pellet-block system just after the pellet collides into the block?
- (c) What is the initial speed of the pellet?

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Section II

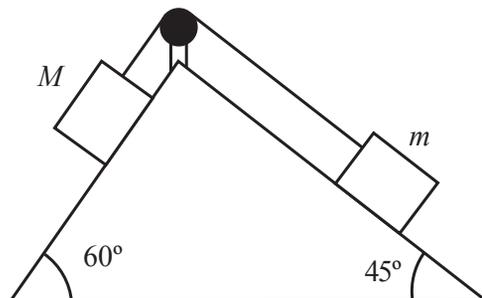
2. A light spring of natural length 10 cm with force constant  $k = 500 \text{ N/m}$  is embedded vertically in the ground. A ball of mass  $m = 0.15 \text{ kg}$  is placed on top of the spring, which is compressed 8.0 cm; when released, the spring pushes the ball. When the ball reaches ground level, it leaves its light supporting platform and continues vertically upward. When it reaches the top of its path, a batter strikes the ball at an angle  $\theta_0$  to the horizontal. Ignore air resistance.



- (a) Find the height  $h$  at which the batter strikes the ball.
- (b) If the batter gives the ball an initial velocity of 30 m/s with  $\theta_0 = 0$  by striking the ball with an impact time of 4 ms, determine:
  - (i) the average force exerted on the ball by the bat.
  - (ii) how long the ball is in flight after it has been hit.
  - (iii) how far the ball travels horizontally.
- (c) If the ball failed to release from the platform, with what frequency would it oscillate?

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3. The figure below shows two boxes attached by a light cord that runs over a frictionless peg. The mass of the block on the  $60^\circ$  incline is  $M = 8$  kg, and the mass of the block on the  $45^\circ$  incline is  $m = 2$  kg.



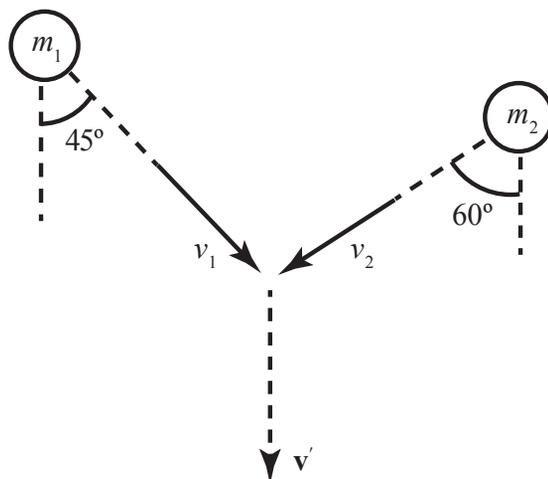
Assume that both inclined surfaces are frictionless for parts (a), (b), and (c).

- Find the acceleration of the blocks once they are released from rest.
- What is the total force exerted by the cord on the peg?
- If block  $M$  is released from rest at a height of  $H = 1.5$  m above the bottom of the triangle, find its speed when it reaches the bottom.
- Answer the question posed in part (a) assuming that the coefficient of sliding friction between the blocks and the inclined surfaces is 0.2.

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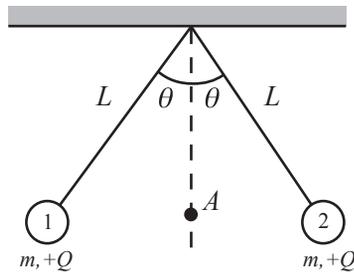


4. The figure below is a view from above of two clay balls moving toward each other on a frictionless surface. They collide perfectly inelastically at the indicated point and are observed to then move in the direction indicated by the post-collision velocity,  $\mathbf{v}'$ . The masses are  $m_1 = 200$  g and  $m_2 = 100$  g, and the speed of  $m_2$  just before impact is  $v_2 = 6.0$  m/s.



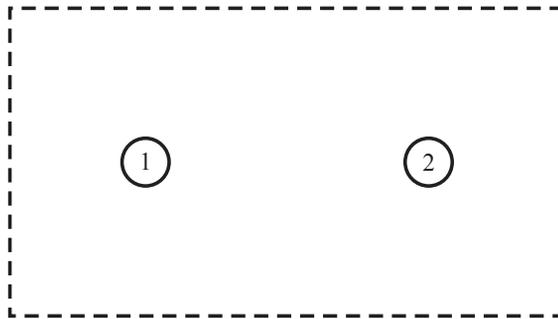
- What is  $v_2$ ?
- What is  $\mathbf{v}'$ , the common speed of the clay balls immediately after the collision?
- How much kinetic energy was lost as a result of the collision?

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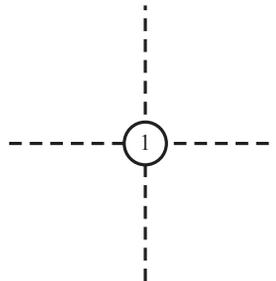


5. Two small objects, labeled 1 and 2 in the diagram above are each suspended in equilibrium from a string of length  $L$  and form an angle  $\theta$  to the normal. Each object has a mass of  $m$  and a charge of  $+Q$ . The strings have negligible mass, are insulated, and are electrically neutral.

- (a) On the following diagram, sketch the net electric field due to the two objects in the region enclosed by the dashed lines.



- (b) On the following diagram of object 1, draw and label vectors to represent the forces on the object.



- (c) In terms of  $m$ ,  $L$ ,  $Q$ ,  $\theta$ , and fundamental constants, derive an equation that shows the tension  $T$  in the left-hand string.

STOP

Completely darken bubbles with a No. 2 pencil. If you make a mistake, be sure to erase mark completely. Erase all stray marks.

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**IMPORTANT:** Please fill in these boxes exactly as shown on the back cover of your test book.

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