Practice Test 4

AP® 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 Question

Chicago is a
(A) state
(B) city
(C) country
(D) continent

Sample Answer

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 TABLE OF INFORMATION

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, $k = 1/4\pi\varepsilon_0 = 9.0 \times 10^9$ N·m^2/C^2
Electron mass, $m_e = 9.11 \times 10^{-31}$ kg	Universal gravitational constant, $G = 6.67 \times 10^{-11}$ m^3/kg·s^2
Speed of light, $c = 3.00 \times 10^8$ m/s	Acceleration due to gravity at Earth's surface, $g = 9.8$ m/s^2

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							
θ	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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ADVANCED PLACEMENT PHYSICS 1 EQUATIONS, EFFECTIVE 2015

MECHANICS

$v_x = v_{x0} + a_x t$

$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$

$v_x^2 = v_{x0}^2 + 2a_x (x - x_0)$

$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$

$|\vec{F}_f| \le \mu |\vec{F}_n|$

$a_c = \frac{v^2}{r}$

$\vec{p} = m\vec{v}$

$\Delta\vec{p} = \vec{F}\,\Delta t$

$K = \frac{1}{2} m v^2$

$\Delta E = W = F_{\parallel} d = F d \cos\theta$

$P = \frac{\Delta E}{\Delta t}$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

$\omega = \omega_0 + \alpha t$

$x = A\cos(2\pi f t)$

$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$

$\tau = r_{\perp} F = r F \sin\theta$

$L = I\omega$

$\Delta L = \tau\,\Delta t$

$K = \frac{1}{2} I \omega^2$

$|\vec{F}_s| = k|\vec{x}|$

$U_s = \frac{1}{2} k x^2$

$\rho = \frac{m}{V}$

a = acceleration
A = amplitude
d = distance
E = energy
f = frequency
F = force
I = rotational inertia
K = kinetic energy
k = spring constant
L = angular momentum
ℓ = length
m = mass
P = power
p = momentum
r = radius or separation
T = period
t = time
U = potential energy
V = volume
v = speed
W = work done on a system
x = position
y = height
α = angular acceleration
μ = coefficient of friction
θ = angle
ρ = density
τ = torque
ω = angular speed

$\Delta U_g = mg\Delta y$

$T = \frac{2\pi}{\omega} = \frac{1}{f}$

$T_s = 2\pi\sqrt{\frac{m}{k}}$

$T_p = 2\pi\sqrt{\frac{\ell}{g}}$

$|\vec{F}_g| = G\frac{m_1 m_2}{r^2}$

$\vec{g} = \frac{\vec{F}_g}{m}$

$U_G = -\frac{G m_1 m_2}{r}$

ELECTRICITY

$|\vec{F}_E| = k\left|\frac{q_1 q_2}{r^2}\right|$

$I = \frac{\Delta q}{\Delta t}$

$R = \frac{\rho\ell}{A}$

$I = \frac{\Delta V}{R}$

$P = I\,\Delta V$

$R_s = \sum_i R_i$

$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$

A = area
F = force
I = current
ℓ = length
P = power
q = charge
R = resistance
r = separation
t = time
V = electric potential
ρ = resistivity

WAVES

$\lambda = \frac{v}{f}$

f = frequency
v = speed
λ = wavelength

GEOMETRY AND TRIGONOMETRY

Rectangle
$A = bh$

Triangle
$A = \frac{1}{2} bh$

Circle
$A = \pi r^2$
$C = 2\pi r$

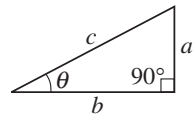
Rectangular solid
$V = \ell w h$

Cylinder
$V = \pi r^2 \ell$
$S = 2\pi r \ell + 2\pi r^2$

Sphere
$V = \frac{4}{3}\pi r^3$
$S = 4\pi r^2$

A = area
C = circumference
V = volume
S = surface area
b = base
h = height
ℓ = length
w = width
r = radius

Right triangle
$c^2 = a^2 + b^2$
$\sin\theta = \frac{a}{c}$
$\cos\theta = \frac{b}{c}$
$\tan\theta = \frac{a}{b}$



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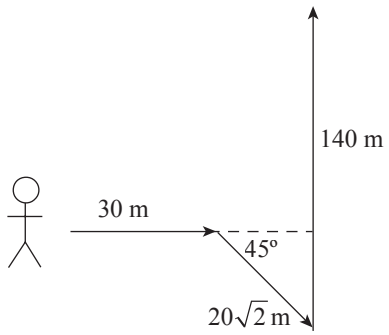
AP PHYSICS 1

SECTION I

Note: To simplify calculations, you may use $g = 10\ m/s^2$ 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.

Questions 1–3 refer to the following scenario:

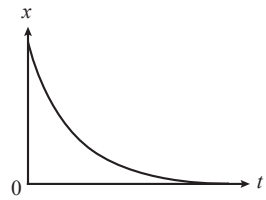


An explorer travels 30 m east, then $20\sqrt{2}$ m in a direction 45° south of east, and then 140 m north.

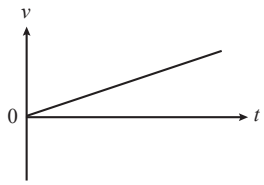
1. What is the distance traveled by the explorer?
   (A) 167.2 m
   (B) 169 m
   (C) 170 m
   (D) 198.2 m

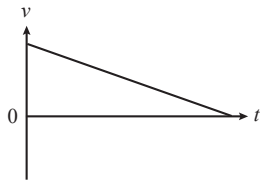
2. What is the displacement of the explorer?
   (A) 130 m
   (B) 169 m
   (C) 170 m
   (D) 215 m

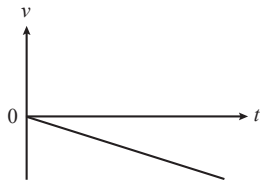
3. The explorer took 60 s, 130 s, and 70 s to travel the 30 m, $20\sqrt{2}$ m, and 140 m north distances, respectively. What is the average velocity of the explorer over the total distance traveled?
   (A) 0.50 m/s
   (B) 33.3 m/min
   (C) 0.76 m/s
   (D) 100 m/min

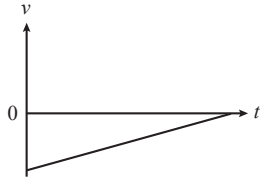


4. The graph above is the position-versus-time graph of an object. Which of the following is the velocity-versus-time graph of the object?

(A)


(B)


(C)


(D)


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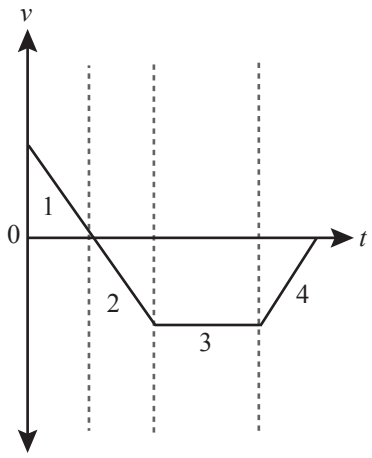
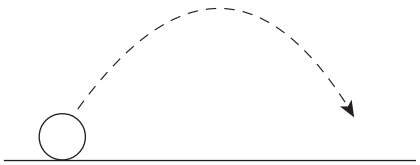
5. In which section of the following velocity-time graph is the object slowing down and moving in the negative direction?

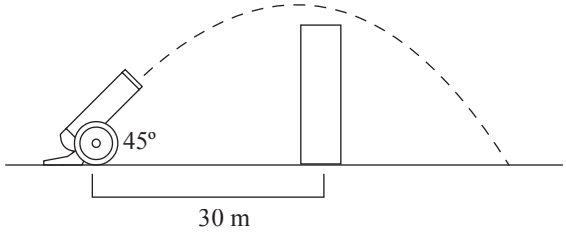


(A) Section 1
(B) Section 2
(C) Section 3
(D) Section 4



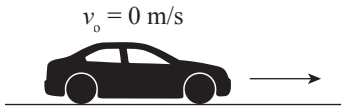
6. Which of the following is true statement regarding the motion of projectiles?

(A) All projectiles have zero velocity at the apex of the trajectory.
(B) The velocity of projectiles is smallest at the apex of the trajectory.
(C) The acceleration of projectiles is greatest at the apex of the trajectory.
(D) Projectiles have maximum kinetic energy at the apex of the trajectory.



7. A cannonball is fired with an initial velocity of 20 m/s and a launch angle of 45° at a wall 30 m away. If the cannonball just barely clears the wall, what is the maximum height of the wall?

(A) 5.92 m
(B) 6.34 m
(C) 7.51 m
(D) 8.32 m



8. A car initially at rest accelerates linearly at a constant rate for 5 s. If the final speed of the car is 15 m/s, what was the acceleration of the car?

(A) 50 m
(B) 100 m
(C) 150 m
(D) 200 m

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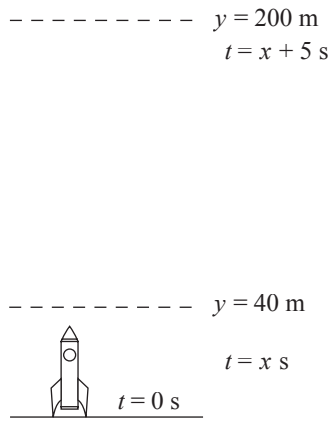
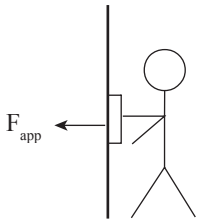


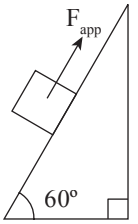
9. A rocket is launched into the air. A few moments after liftoff, the rocket is 40 m above the ground. After another 5 s, the rocket is now 200 m off the ground. What is the average velocity of the rocket during the 5 s part of the flight?

   (A) 16 m/s
   (B) 32 m/s
   (C) 48 m/s
   (D) 64 m/s



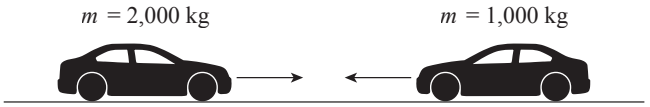
10. A student presses a 0.5 kg book against the wall. If the μ_s between the book and the wall is 0.2, what force must the student apply to hold the book in place?

    (A) 0 N
    (B) 15 N
    (C) 25 N
    (D) 35 N



11. A box with a mass of 10 kg is placed on an inclined plane that makes a 60° angle with the horizontal. The coefficient of static fraction (μ_s) between the box and the inclined plane is 0.2. What force must be applied on the box in order to prevent the box from sliding down the inclined plane?

    (A) 32.7 N
    (B) 48.3 N
    (C) 56.2 N
    (D) 76.6 N



12. A 2000 kg car has a head-on collision with a 1000 kg car. How does the impact force force on the heavier car compare with that of the smaller car?

    (A) The heavier car experiences a greater impact force.
    (B) The smaller car experiences a greater impact force.
    (C) Both vehicles experience an impact force with the same magnitude.
    (D) Cannot be determined

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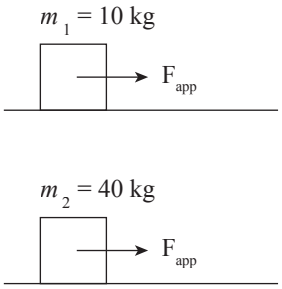
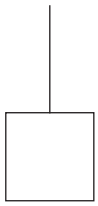


13. Two students push two different boxes across a frictionless floor. Both students exert a horizontal force of 50 N. If the first box has mass m_1 = 10 kg and the second box has mass m_2 = 40 kg, what is the value of a_1/a_2 ?

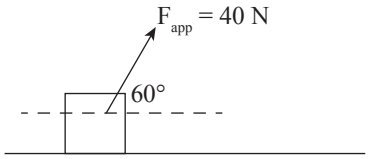
(A) 1/4
(B) 1/2
(C) 2
(D) 4



m = 4 kg

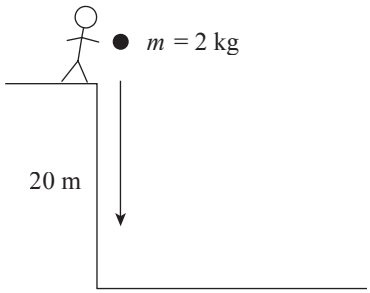
14. A 4 kg box is accelerated upwards by a string with a breaking strength of 80 N. What is the maximum upward acceleration that can be applied on the box without breaking the string?

(A) 2.5 m/s^2
(B) 5.0 m/s^2
(C) 7.5 m/s^2
(D) 10 m/s^2



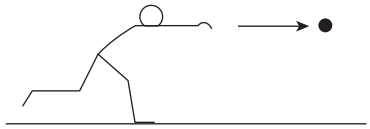
15. A worker moves a 30 kg box by pulling on it with a rope that makes a 60° angle with the horizontal. If the worker applies a force of 40 N and pulls the box over a distance of 20 m, how much work did the worker do?

(A) 100 J
(B) 200 J
(C) 400 J
(D) 800 J



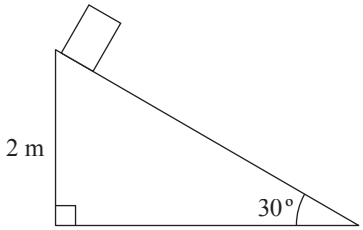
16. A 2 kg rock is dropped off a cliff with a height of 20 m. What the speed of the rock at the bottom of the hill?

(A) 10 m/s
(B) 14 m/s
(C) 20 m/s
(D) 40 m/s



17. How much work is done by a pitcher in throwing a 0.2 kg ball at a speed of 30 m/s ?

(A) 3 J
(B) 9 J
(C) 30 J
(D) 90 J



18. A 10 kg block is placed at the top of an inclined plane with an angle of incline of 30 and μ_k = 0.1. If the height of the inclined plane is 2 m, what is the kinetic energy of the block when it is halfway down the incline?

(A) 64 J
(B) 72 J
(C) 91 J
(D) 100 J

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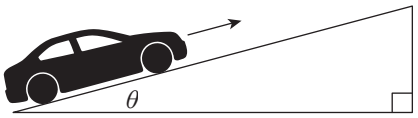
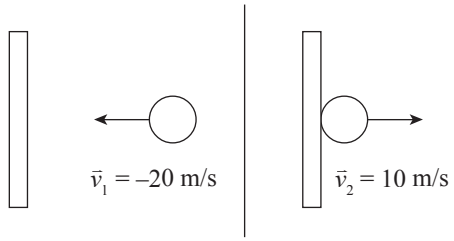


19. A car's engine must exert a force of 2,000 N to maintain a speed of 30 m/s up an incline. What is the power provided by the engine during this motion?

(A) 20 N
(B) 40 N
(C) 80 N
(D) 160 N

Questions 20–22 refer to the following scenario:



A 2 kg ball with a velocity of –20 m/s collides with the wall and bounces back with a velocity of 10 m/s.

20. What is the impulse during the collision?

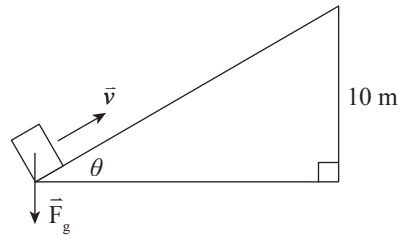
(A) 10 N·s
(B) 20 N·s
(C) 30 N·s
(D) 60 N·s

21. If the ball is in contact with the wall for 0.002 s, determine the average force experienced by the ball.

(A) 3,000 N
(B) 5,000 N
(C) 30,000 N
(D) 50,000 N

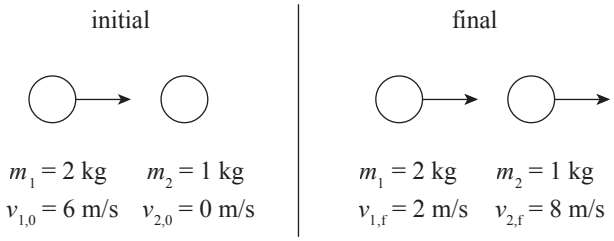
22. How much work did the wall do on the ball?

(A) –300 J
(B) –400 J
(C) –750 J
(D) –1,000 J



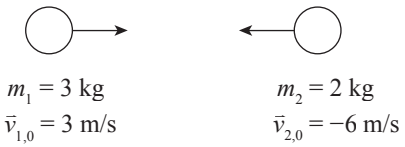
23. A student pushes a 6 kg box up an inclined plane with a height of 10 m. How much work does gravity do on the box during this process?

(A) –1,200 J
(B) –600 J
(C) 600 J
(D) 1,200 J



24. A 2 kg ball traveling to the right at 6 m/s collides head on with a 1 kg ball at rest. After impact, the 2 kg ball is traveling to the right at 2 m/s and the 1 kg ball is traveling to the right at 8 m/s. What type of collision occurred?

(A) Inelastic
(B) Perfectly inelastic
(C) Elastic
(D) Cannot be determined



25. A 3 kg mass with a initial velocity of +3 m/s has a perfectly inelastic collision with a 2 kg mass with an initial velocity of –6 m/s. What is the final velocity after impact?

(A) –1.0 m/s
(B) –0.6 m/s
(C) 0.6 m/s
(D) 1.0 m/s

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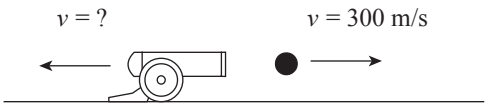
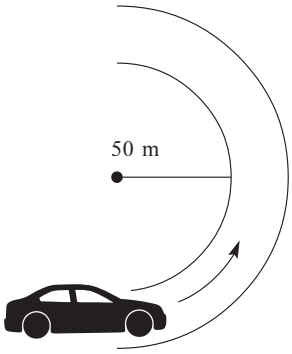


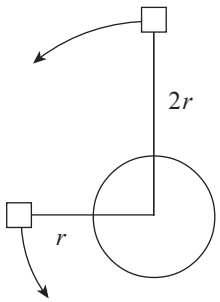
26. A soldier loads a 10 kg cannonball into a 300 kg cannon that is initially at rest on the ground. What is the recoil speed of the cannon if the cannonball is fired with a horizontal velocity of 300 m/s ?

(A) 5 m/s
(B) 7.5 m/s
(C) 10 m/s
(D) 15 m/s



27. A car is driving on a flat curve with a radius of 50 m. If the coefficient of friction between the ground the car's tires is 0.8, what is the maximum speed of the car in order to make the curve without sliding?

(A) 8 m/s^2
(B) 12 m/s^2
(C) 16 m/s^2
(D) 20 m/s^2



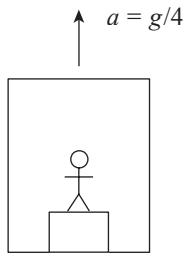
28. If the speed of a satellite orbiting the Earth at a distance r from the center of the Earth is v, what is the speed of a second satellite orbiting the Earth at a distance $2r$ from the center of the Earth?

(A) 2v

(B) $\sqrt{2}v$

(C) $\frac{1}{\sqrt{2}}v$

(D) $\frac{1}{2}v$



29. A 50 kg man stands on a scale that measures force in an elevator traveling up with an acceleration of $g/4$. What will the scale read?

(A) 375 N
(B) 500 N
(C) 575 N
(D) 625 N

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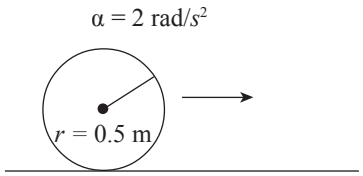
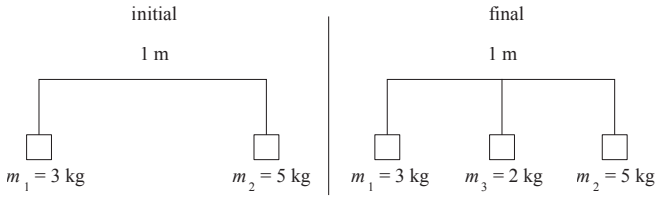


30. A mechanical wheel initially at rest on the floor begins rolling forward with an angular acceleration of rad/s². If the radius of the wheel is 0.5 m, what is the linear velocity of the wheel after 5 s ?

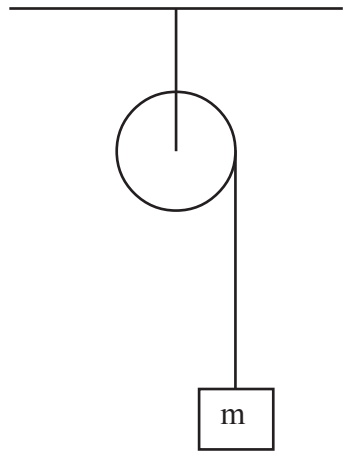
(A) 0.5 m/s
(B) 1 m/s
(C) 5 m/s
(D) 10 m/s



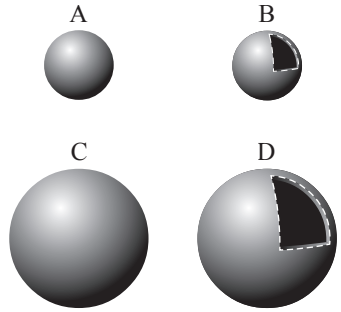
31. Two masses are attached to a 1 m long massless bar. Mass 1 is 3 kg and is attached to the far left side of the bar. Mass 2 is 5 kg and is attached to the far right side of the bar. If a third mass that is 2 kg is added to the middle of the bar, how does the center of mass of the system change?

(A) The center of mass shifts to the left by 0.025 m.
(B) The center of mass shifts to the right by 0.025 m.
(C) The center of mass shifts to the left by 0.075 m.
(D) The center of mass shifts to the right by 0.075 m.

32. A 5 kg box is connected to a pulley with rope in the diagram shown below. If the radius of the pulley is 0.5 m, what is the torque generated by the box on the pulley?



(A) 10 N·m
(B) 25 N·m
(C) 50 N·m
(D) 75 N·m



33. Which of the following objects has the greatest rotational inertia?

(A) A 1 kg solid ball with radius of 5 cm
(B) A1 kg hollow ball with radius of 5 cm
(C) A 5 kg solid ball with radius of 5 cm
(D) A 5 kg hollow ball with radius 5 cm

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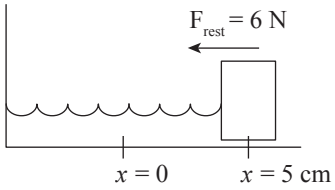
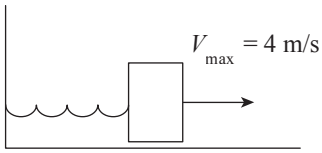


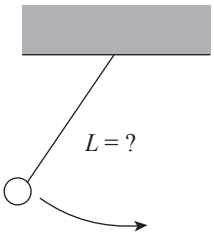
34. A horizontal spring is attached to a 5 kg block. When the block is pulled 5 cm to the right, the restoring force has a magnitude of 6 N. What is the frequency of the spring?

(A) 0.32 Hz
(B) 0.56 Hz
(C) 0.78 Hz
(D) 0.98 Hz



35. A 3 kg block is attached to a horizontal spring with a force constant of 10 N/m. If the maximum speed of the block is 4 m/s, what is the amplitude of the block?

(A) 0.55 m
(B) 1.1 m
(C) 2.2 m
(D) 4.4 m

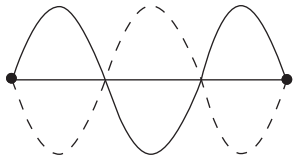


36. A simple pendulum oscillates back and forth with a period of 2 s. What is the length of the string of the pendulum?

(A) 0.25 m
(B) 0.5 m
(C) 1 m
(D) 2 m

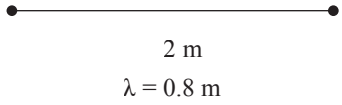
37. The speed of sound in air is 343 m/s. If the wavelength of a certain sound wave is 20.0 cm, what is its frequency?

(A) 171.5 Hz
(B) 1,715 Hz
(C) 3,430 Hz
(D) 17,150 Hz



38. Which of the following is a true statement about standing waves?

(A) Standing waves have zero amplitude at antinodes.
(B) Standing waves have maximum amplitude at nodes.
(C) Complete constructive interference occurs at nodes.
(D) Complete destructive interference occurs at nodes.



39. A string of length 2 m that's fixed at both ends supports a standing wave with a wavelength of 0.8 m. What is the harmonic number of this standing wave?

(A) 3
(B) 4
(C) 5
(D) 6

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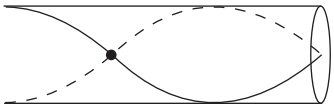
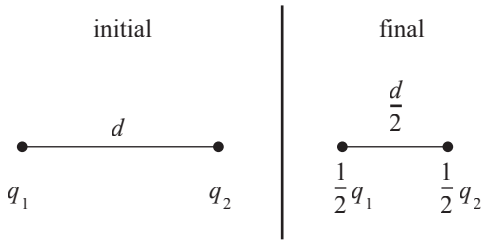


$L = 0.5$ m

40. What is the frequency of the third harmonic standing wave in an open tube with a length of 0.5 m? The speed of sound in the tube is 343 m/s.

(A) 514.5 Hz
(B) 1029 Hz
(C) 2058 Hz
(D) 4116 Hz

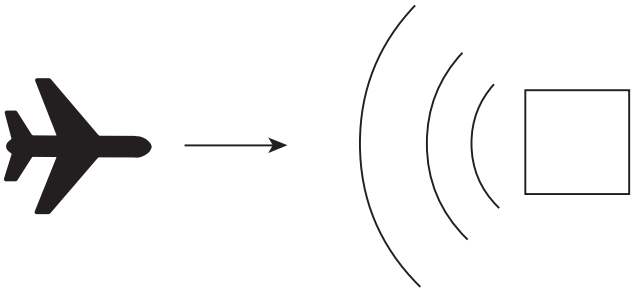


41. What happens to the magnitude of the electric force between two opposite charges if the magnitude of each charge is halved and the distance between their centers is halved?

(A) It is doubled.
(B) It is quadrupled.
(C) It is halved.
(D) It remains the same.

42. As a train approaches the next stop, the conductor blows the horn and applies the breaks on the train. What will a person standing at the train stop hear as the train approaches?

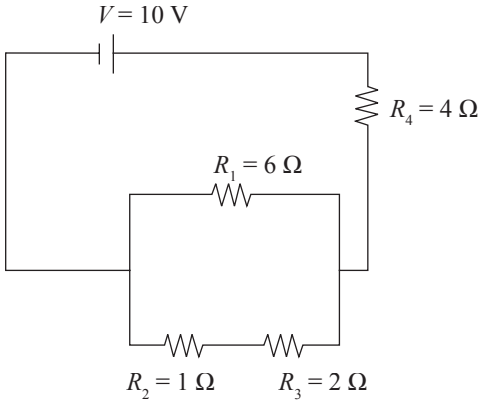
(A) A decrease in the frequency and an increase in the intensity of the horn
(B) An increase in the frequency and a decrease in the intensity of the horn
(C) A decrease in both the frequency and intensity of the horn
(D) An increase in both the frequency and intensity of the horn



43. A plane traveling at half the speed of sound flies toward a stationary sound source emitting sound waves with wavelength λ. What is the wavelength of the waves as the plane receives them?

(A) $\frac{1}{2}\lambda$
(B) $\frac{2}{3}\lambda$
(C) $\frac{3}{2}\lambda$
(D) 2λ

Questions 44–45 refer to the following circuit below:



44. What is the total resistance of the circuit?

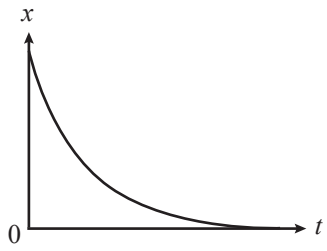
(A) 13 Ω
(B) 11 Ω
(C) 8 Ω
(D) 6 Ω

GO ON TO THE NEXT PAGE.

45. How long will it take for the battery to deliver 300 J of energy to the circuit?

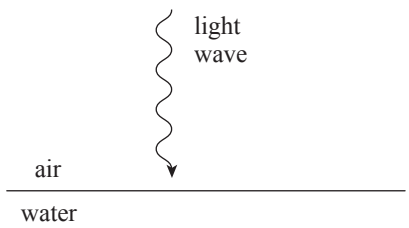
(A) 6 s
(B) 12 s
(C) 18 s
(D) 24 s

Directions: For each of the questions 46-50, <u>two</u> 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.



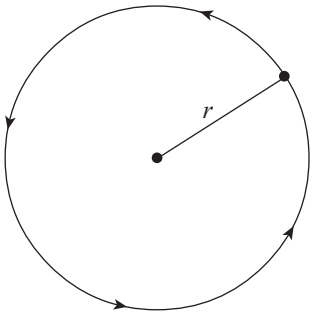
46. The graph above is the position-versus-time graph of an object. Which of the following is true regarding the motion of the object? Select two answers.

(A) The object is moving in the positive direction.
(B) The object is moving in the negative direction.
(C) The acceleration of the object is decreasing
(D) The speed of the object is decreasing



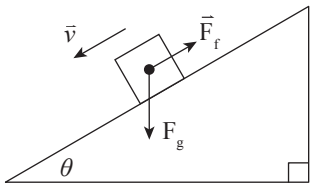
47. When a light wave passes from air into water, what properties of the wave change? Select two answers.

(A) Frequency
(B) Energy
(C) Wavelength
(D) Speed



48. Which of the following statements is true regarding an object undergoing uniform circular motion? Select two answers.

(A) The velocity of the object must be constant.
(B) The speed of the object must be constant.
(C) The acceleration of the object must point away from the center of the circle.
(D) The acceleration of the object must point toward center of the circle.



49. Which of the following is true regarding conservative forces? Select two answers.

(A) The work done by conservative forces is path dependent.
(B) The work done by conservative forces is path independent.
(C) Gravity is a conservative force.
(D) Friction is a conservative force.

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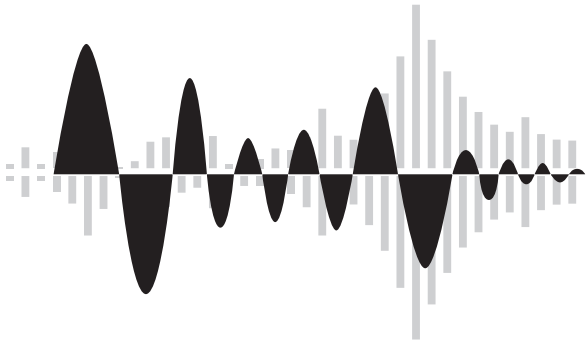


50. What does the speed of a wave depend on? Select two answers.

(A) The energy of the wave
(B) The frequency of the wave
(C) The type of wave
(D) The characteristics of the medium

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

General Instructions

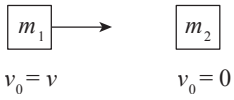
Use a separate piece of paper to answer these questions. Show your work. Be sure to write CLEARLY and LEGIBLY. If you make an error, you may save time by crossing it out rather than trying to erase it.

GO ON TO THE NEXT PAGE.

AP PHYSICS 1

SECTION II

Directions: Questions 1, 2, and 3 are short free-response questions that require about 13 minutes to answer and are worth 8 points. 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.

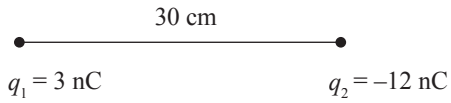


1. A mass m_1 traveling with an initial velocity of v has an elastic collision with a mass m_2 initially at rest.

   (a) Determine the final velocity v_1 of m_1 in terms of m_1, m_2, and v.

   (b) Determine the final velocity v_2 of m_2 in terms of m_1, m_2, and v.

   (c) For what values of m_1 and m_2 would the final velocities of the two masses be in the same direction? The opposite direction?



2. Two charges, $q_1 = +3$ nC and $q_2 = -12$ nC, are fixed in place and separated by a distance of 30 cm.

   (a) What is the magnitude of the electric force between the two charges? Is the force attractive or repulsive?

   (b) At what point between the two charges is the electric field equal to 0?

   (c) What is the electric field at the midpoint between the two charges?

   (d) What is the magnitude of the electric force on a charge $q_3 = +2$ nC placed in the middle of the two charges?

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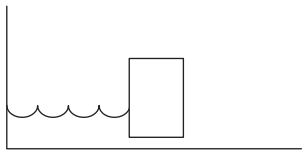


$m = 0.1$ kg

$k = 40$ N/m

3. A horizontal spring with a force constant of 40 N/m is attached a 0.1 kg block.

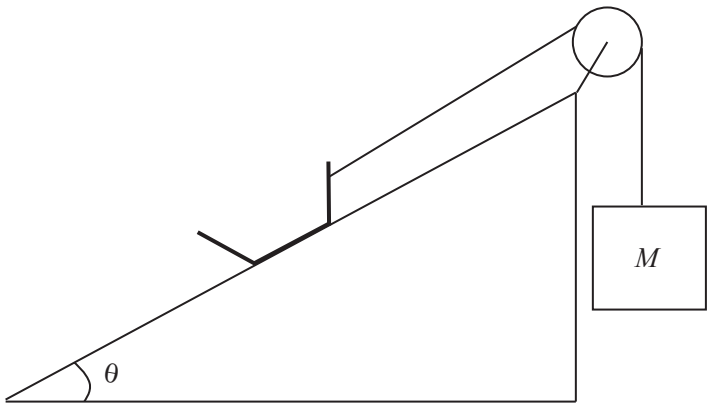
   (a) If the block is pulled to a distance of 0.5 m and released, what is the maximum speed of the block?

   (b) What is the frequency of the oscillations?

   (c) If the spring were flipped vertically and attached to the ground with the block placed on top, how would the natural length of the spring change?

   (d) How does the frequency of the oscillations of the vertical spring-block oscillator compare with that when it was placed horizontally?

4. A massless tray is placed on an inclined plane with an angle of incline of θ. There is a coefficient of static friction μ_s between the inclined plane and the massless tray. The tray is attached to a box of mass M by the pulley system shown below.



   (a) If mass can loaded onto the massless tray, how much mass m has to be loaded to stop the tray from being pulled up the inclined plane by M?

   (b) How much mass m has to be loaded until the tray starts sliding down the inclined plane?

   (c) If $\mu_k = 0.3$ and $\theta = 45°$, what is the acceleration of the massless tray if $m = 4M$?

GO ON TO THE NEXT PAGE.

5. A machine launches a 2 kg ball to the right with an initial velocity 16 m/s at a launched angle of 30° to a student standing 20 m away with a baseball bat.

(a) What height must the student swing the bat to hit the ball?

(b) What is the magnitude of the velocity of the ball just before impact?

(c) If the student hits the ball with an upwards vertical velocity of 5 m/s and horizontal velocity of 12 m/s to the left, what are the horizontal and vertical components of the impulse of the ball from the collision?

(d) If the impact time with the bat was 0.05 s, what is the magnitude of the average force experienced by the ball during impact?

(e) What is the direction of the average force experienced by the ball during impact?

STOP

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

1.

YOUR NAME: (Print) _____ Last _____ First _____ M.I.

SIGNATURE: _____ DATE: / /

HOME ADDRESS: (Print) _____ Number and Street

_____ City _____ State _____ Zip Code

PHONE NO.: (Print) _____

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

2. TEST FORM

6. DATE OF BIRTH

Month	Day		Year	
○ JAN				
○ FEB	0	0	0	0
○ MAR	1	1	1	1
○ APR	2	2	2	2
○ MAY	3	3	3	3
○ JUN		4	4	4
○ JUL		5	5	5
○ AUG		6	6	6
○ SEP		7	7	7
○ OCT		8	8	8
○ NOV		9	9	9
○ DEC				

3. TEST CODE

0	A	J	0	0
1	B	K	1	1
2	C	L	2	2
3	D	M	3	3
4	E	N	4	4
5	F	O	5	5
6	G	P	6	6
7	H	Q	7	7
8	I	R	8	8
9			9	9

4. REGISTRATION NUMBER

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
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5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

7. SEX

○ MALE
○ FEMALE

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5. YOUR NAME

First 4 letters of last name					FIRST INIT	MID INIT
A	A	A	A		A	A
B	B	B	B		B	B
C	C	C	C		C	C
D	D	D	D		D	D
E	E	E	E		E	E
F	F	F	F		F	F
G	G	G	G		G	G
H	H	H	H		H	H
I	I	I	I		I	I
J	J	J	J		J	J
K	K	K	K		K	K
L	L	L	L		L	L
M	M	M	M		M	M
N	N	N	N		N	N
O	O	O	O		O	O
P	P	P	P		P	P
Q	Q	Q	Q		Q	Q
R	R	R	R		R	R
S	S	S	S		S	S
T	T	T	T		T	T
U	U	U	U		U	U
V	V	V	V		V	V
W	W	W	W		W	W
X	X	X	X		X	X
Y	Y	Y	Y		Y	Y
Z	Z	Z	Z		Z	Z

1.	A	B	C	D	14.	A	B	C	D
2.	A	B	C	D	15.	A	B	C	D
3.	A	B	C	D	16.	A	B	C	D
4.	A	B	C	D	17.	A	B	C	D
5.	A	B	C	D	18.	A	B	C	D
6.	A	B	C	D	19.	A	B	C	D
7.	A	B	C	D	20.	A	B	C	D
8.	A	B	C	D	21.	A	B	C	D
9.	A	B	C	D	22.	A	B	C	D
10.	A	B	C	D	23.	A	B	C	D
11.	A	B	C	D	24.	A	B	C	D
12.	A	B	C	D	25.	A	B	C	D
13.	A	B	C	D	26.	A	B	C	D

27.	A	B	C	D	40.	A	B	C	D
28.	A	B	C	D	41.	A	B	C	D
29.	A	B	C	D	42.	A	B	C	D
30.	A	B	C	D	43.	A	B	C	D
31.	A	B	C	D	44.	A	B	C	D
32.	A	B	C	D	45.	A	B	C	D
33.	A	B	C	D	46.	A	B	C	D
34.	A	B	C	D	47.	A	B	C	D
35.	A	B	C	D	48.	A	B	C	D
36.	A	B	C	D	49.	A	B	C	D
37.	A	B	C	D	50.	A	B	C	D
38.	A	B	C	D					
39.	A	B	C	D					