Practice Test 1

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.

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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

$v_x = v_{x0} + a_x t$

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

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

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

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

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

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

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

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

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

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

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

$\omega = \omega_0 + \alpha t$

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

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

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

$L = I\omega$

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

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

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

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

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

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

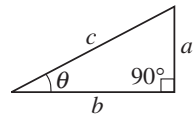
Rectangular solid
$V = \ell wh$

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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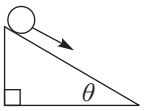
AP PHYSICS 1

SECTION I

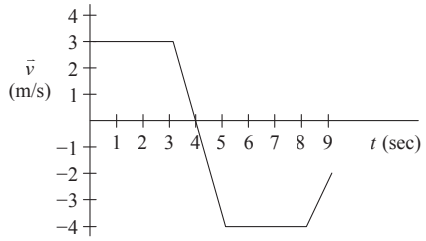
Note: To simplify calculations, you may use $g = 10\ m/s^2$ in all problems.

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.



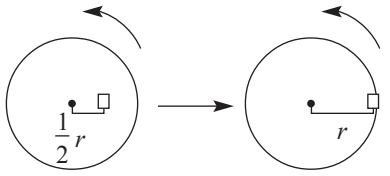
1. If a ball is rolling down an inclined plane without slipping, which force is responsible for causing its rotation?

   (A) Normal force
   (B) Gravity
   (C) Kinetic friction
   (D) Static friction



2. The graph above shows the velocity of an object as a function of time. What is the net displacement of the object over the time shown?

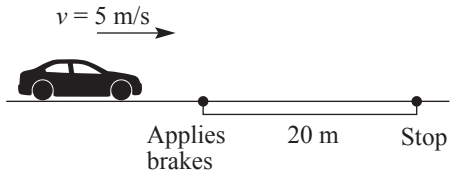
   (A) –30.5 m
   (B) –6.5 m
   (C) 6.5 m
   (D) 30.5 m



Top view

3. An object is resting on a platform that rotates at a constant speed. At first, it is a distance of half the platform's radius from the center. If the object is moved to the edge of the platform, what happens to the centripetal force that it experiences? Assume the platform continues rotating at the same speed.

   (A) Increases by a factor of 4
   (B) Increases by a factor of 2
   (C) Decreases by a factor of 2
   (D) Decreases by a factor of 4



4. A car of mass 1000 kg is traveling at a speed of 5 m/s. The driver applies the breaks, generating a constant friction force, and skids for a distance of 20 m before coming to a complete stop. Given this information, what is the coefficient of friction between the car's tires and the ground?

   (A) 0.25
   (B) 0.2
   (C) 0.125
   (D) 0.0625

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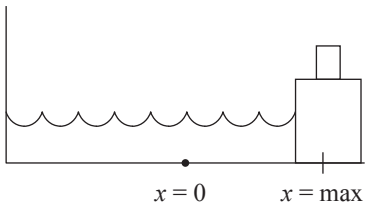
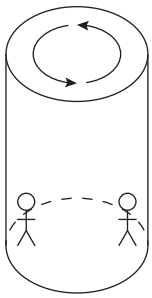


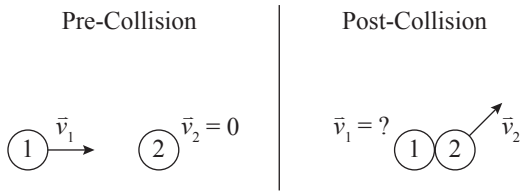
5. A spring-block system is oscillating without friction on a horizontal surface. If a second block of equal mass were placed on top of the original block at a time when the spring is at maximum compression, which of the following quantities would NOT be affected?

   (A) Frequency
   (B) Maximum speed
   (C) Amplitude
   (D) All of the above quantities would be affected.



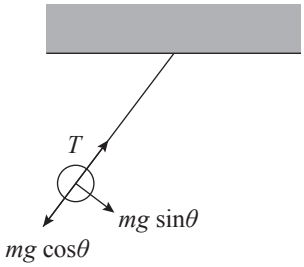
6. A certain theme park ride involves people standing against the walls of a cylindrical room that rotates at a rapid pace, making them stick to the walls without needing support from the ground. Once the ride achieves its maximum speed, the floor drops out from under the riders, but the circular motion holds them in place. Which of the following factors could make this ride dangerous for some riders but not others?

   (A) The mass of the individuals
   (B) The coefficient of friction of their clothing in contact with the walls
   (C) Both of the above
   (D) None of the above



7. Two balls collide as shown above. Given the final direction of the second ball's motion after the collision, which of the following is a possible direction for the first ball to move after the collision?

   (A) ↖
   (B) ←
   (C) →
   (D) ↘



8. As a pendulum swings back and forth, it is affected by two forces: gravity and tension in the string. Splitting gravity into component vectors, as shown above, produces $mg\sin\theta$ (the restoring force) and $mg\cos\theta$. Which of the following correctly describes the relationship between the magnitudes of tension in the string an $mg\cos\theta$?

   (A) Tension > $mg\cos\theta$
   (B) Tension = $mg\cos\theta$
   (C) Tension < $mg\cos\theta$
   (D) The relationship depends on the position of the ball.

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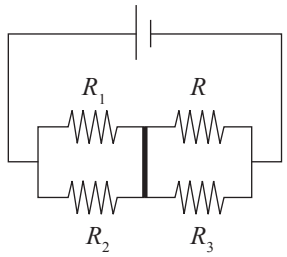


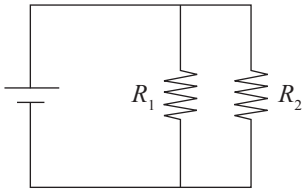
9. In order to ensure that no current will pass through the cross path (bold in the image above), what must the resistance of R be in terms of R_1, R_2, and R_3?

(A) $R = \dfrac{R_1 + R_3}{R_2}$

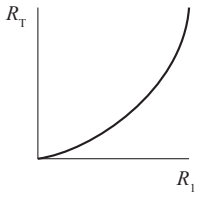
(B) $R = \dfrac{R_2}{R_1 + R_3}$

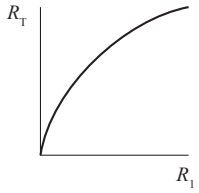
(C) $R = \dfrac{R_1 R_3}{R_2}$

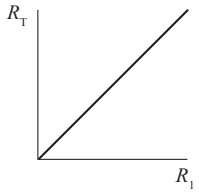
(D) $R = \dfrac{R_2}{R_1 R_3}$

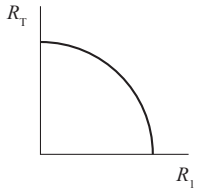


10. The circuit above has two resistors in parallel. The first, R_1, will have its resistance steadily increased. The second, R_2, will have a constant resistance of $R_2 = 4\ \Omega$. Which of the following graphs correctly depicts the total resistance of the circuit, R_T, as a function of R_1?

(A)


(B)


(C)


(D)


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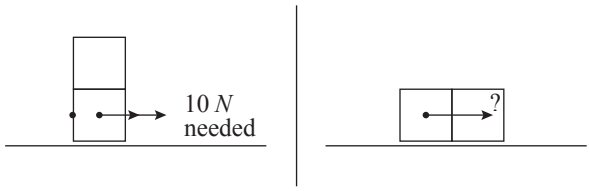
11. A piano tuner needs to double the frequency of note that a particular string is playing. Should he/she tighten or loosen the string, and by what factor?

    (A) Tighten, 4
    (B) Tighten, 2
    (C) Loosen, 2
    (D) Loosen, 4

12. If two people pull with a force of 1000 N each on opposite ends of a rope and neither person moves, what is the magnitude of tension in the rope?

    (A) 0 N
    (B) 500 N
    (C) 1000 N
    (D) 2000 N



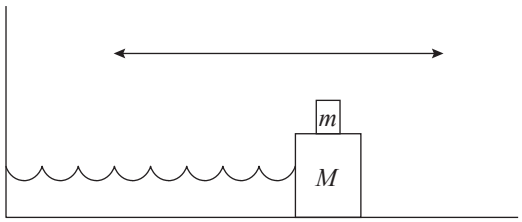
13. Two identical blocks are stacked on top of each other and placed on a table. To overcome the force of static friction, a force of 10 N is required. If the blocks were placed side by side and pushed as shown in the figure above, how much force would be required to move them?

    (A) $\frac{10\sqrt{2}}{2\,\mathrm{N}}$

    (B) 10 N

    (C) $10\sqrt{2}$ N

    (D) 20 N



14. A block of known mass *M* is connected to a horizontal spring that is sliding along a flat, frictionless surface. There is an additional block of known mass m resting on top of the first block. Which of the following quantities would NOT be needed to determine if the top block will slide off the bottom block?

    (A) The maximum coefficient of static friction between the blocks
    (B) The amplitude of the system's motion
    (C) The spring constant
    (D) The average speed of the blocks

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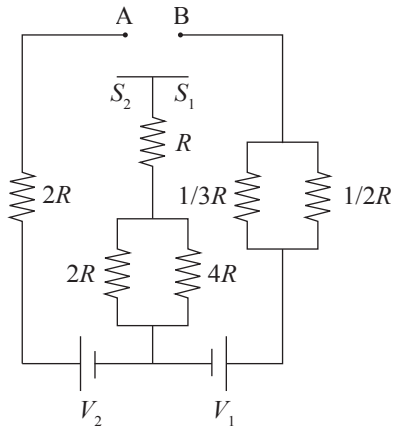
Questions 15–17 all refer to the below circuit diagram.



15. If switch S_1 is connected to point B but switch S_2 is left unconnected, what is the current through the resistor labeled R ?

(A) $\frac{47V_1}{6R}$

(B) $\frac{38V_1}{15R}$

(C) $\frac{15V_1}{38R}$

(D) $\frac{6V_1}{47R}$

16. If switch S_2 is connected to point A but switch S_1 is left unconnected, what is the current through the resistor labeled R ?

(A) $\frac{9V_2}{R}$

(B) $\frac{13V_2}{3R}$

(C) $\frac{3V_2}{13R}$

(D) $\frac{V_2}{9R}$

17. If both switches S_1 and S_2 are left in the unconnected positions, what is the current through the resistor labeled R ?

(A) 0

(B) $\frac{15(V_1 + V_2)}{68R}$

(C) $\frac{15(V_1 + V_2)}{103R}$

(D) $\frac{15(V_2 - V_1)}{68R}$

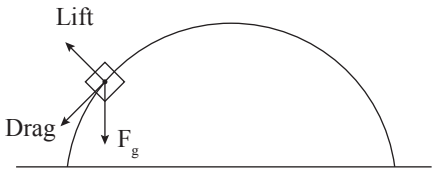
18. When a person runs to the right, as shown above, which of the following could be the direction of the force from the ground on his/her foot?

(A) 

(B)

(C) 

(D) None of these are possible.



19. In real projectile motion, an object experiences three forces: gravity, drag, and lift. These are depicted in the picture above. Given this information, how would lift affect the speed of a projectile?

(A) It would increase speed.
(B) It would decrease speed.
(C) Its effect would vary throughout the flight of the object.
(D) It would have no effect.

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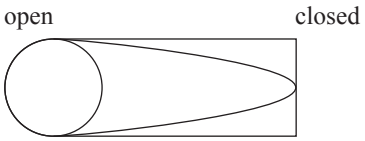
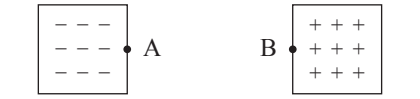


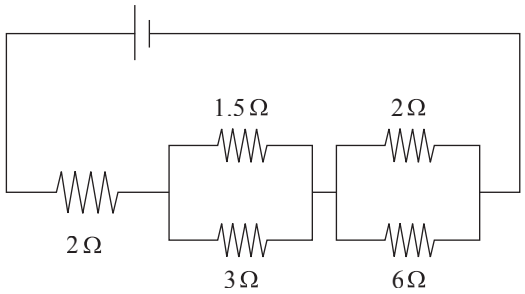
20. A standing wave is formed in a tube, as shown above. If this wave has a frequency of f, what would be the frequency of the next harmonic that can be formed in this tube?

(A) $\frac{1}{2}f$
(B) $2f$
(C) $3f$
(D) The above wave shows the highest possible harmonic frequency for this system.

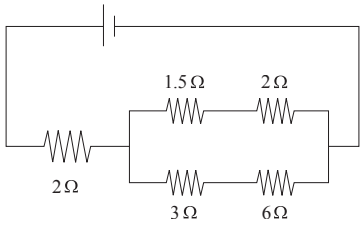


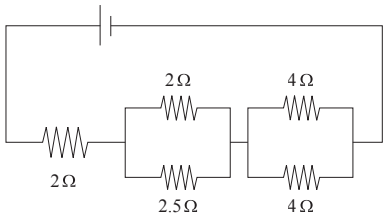
21. Which of the following correctly describes an electron moving from point A to point B in the situation above? Assume the two regions of charge are identical in magnitude and only different in sign.

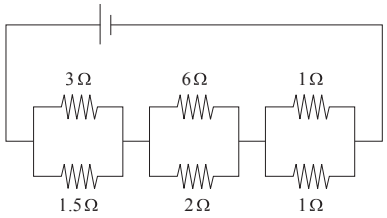
(A) The electron moves with increasing speed and increasing acceleration and loses potential energy.
(B) The electron moves with increasing speed and constant acceleration and loses potential energy.
(C) The electron moves with increasing speed and increasing acceleration and gains potential energy.
(D) The electron moves with decreasing speed and decreasing acceleration and gains potential energy.

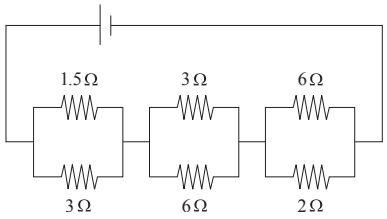


22. Which of the following circuits would have an equivalent resistance equal to that of the circuit depicted above?

(A)


(B)


(C)


(D)


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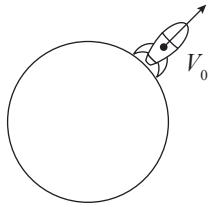
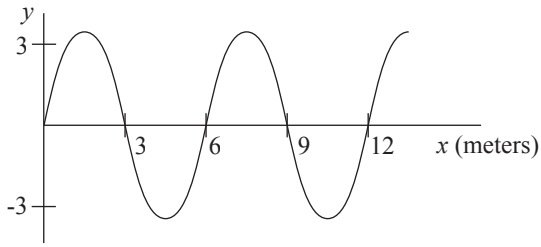


23. Escape velocity is defined as the minimum speed at which an object must be launched to "break free" from a massive body's gravitational pull. Which of the following principles could be used to derive this speed for a given planet?

(A) Conservation of Linear Momentum
(B) Newton's Second Law
(C) Conservation of Angular Momentum
(D) Conservation of Energy

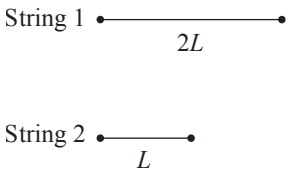
24. An ambulance is driving toward you. As it approaches, which of the following correctly describe the changes in the sound of the siren's pitch and intensity?

(A) Increasing pitch, increasing intensity
(B) Increasing pitch, decreasing intensity
(C) Decdecreasing pitch, increasing intensity
(D) Decreasing pitch, decreasing intensity



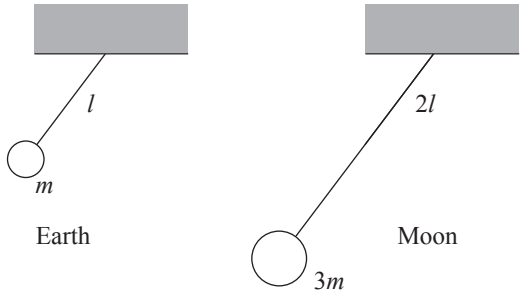
25. The graph above depicts a wave's amplitude as a function of distance. If the wave has a speed of 600 m/s, which off the following is the best approximation of the wave's frequency?

(A) 50 Hz
(B) 100 Hz
(C) 200 Hz
(D) Cannot be determined without additional information



26. Both of the above strings have their ends locked in place. The first string, S_1, is twice as long as the second string, S_2. If sound waves are going to be sent through both, what is the correct ratio of the fundamental frequency of S_1 to the fundamental frequency of S_2?

(A) 2:1
(B) $\sqrt{2}$:1
(C) 1:$\sqrt{2}$
(D) 1:2



27. A pendulum with a ball of mass m hanging from a string of length l is set in motion on Earth, and the system is found to have a frequency of f. If the length of the string were doubled, the hanging mass tripled, and the system moved to the moon, what would be the new frequency? NOTE: Acceleration due to gravity of the Moon is approximately $\frac{1}{6}$ of Earth's.

(A) $\frac{1}{12}f$
(B) $\sqrt{\frac{1}{12}}f$
(C) $\sqrt{12}f$
(D) $12f$

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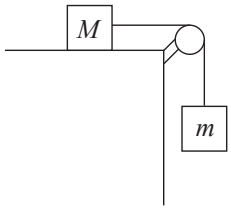
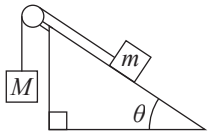


28. A block of mass M is at rest on a table. It is connected by a string and pulley system to a block of mass m hanging off the edge of the table. Assume the hanging mass is heavy enough to make the resting block move. If the acceleration of the system and the masses of the blocks are known, which of the following could NOT be calculated?

(A) Net force on each block
(B) Tension in the string
(C) Coefficient of kinetic friction between the table and the block of mass M
(D) The speed of the block of mass M when it reaches the edge of the table



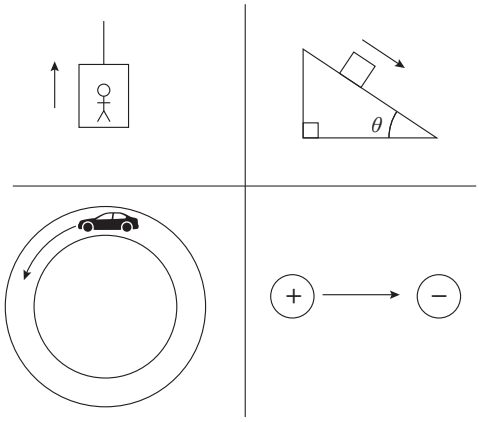
29. A block of mass m is connected by a string which runs over a frictionless pulley to a heavier block of mass M. The smaller block rests on an inclined plane of angle θ, and the larger block hangs over the edge, as shown above. In order to prevent the blocks from moving, the coefficient of static friction must be

(A) $\dfrac{mg\sin\theta}{Mg - mg\cos\theta}$

(B) $\dfrac{Mg - mg\sin\theta}{Mg\cos\theta}$

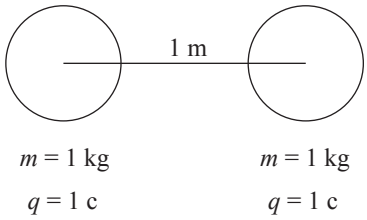
(C) $\dfrac{Mg - mg\sin\theta}{mg\cos\theta}$

(D) $\dfrac{Mg - mg\cos\theta}{mg\sin\theta}$



30. Which of the following forces does not do work in its given situation?

(A) Normal force as a person goes up in an elevator
(B) Frictional force as a box slides down a ramp
(C) Centripetal force as a car drives around a circular track
(D) Electrical force as a positive charge moves toward a negative charge



31. Two identical spheres of mass 1 kg are placed 1 m apart from each other. Each sphere pulls on the other with a gravitational force, F_g. If each sphere also holds 1 C of positive charge, then the magnitude of the resulting repulsive electric force is

(A) $1.82 \times 10^{40} F_g$
(B) $1.35 \times 10^{20} F_g$
(C) $7.42 \times 10^{-21} F_g$
(D) $5.50 \times 10^{-41} F_g$

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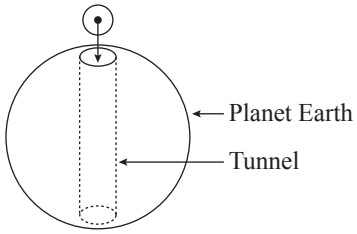
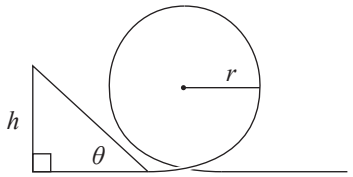


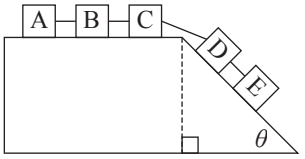
32. If a hole were dug through the center of a planet and a ball dropped into the hole, which of the following best describes the motion that the ball would undergo? Assume the ball is indestructible and the planet is a perfect sphere.

(A) It would continuously gain speed and eventually escape the gravitational pull of the planet.
(B) It would fall to the center of the planet and get stuck there because gravity is always pulling things toward the center of the planet.
(C) It would fall to the other end of the hole, come to a momentary stop, fall back to the starting location, and then repeat this back-and-forth motion indefinitely.
(D) None of the above is correct.



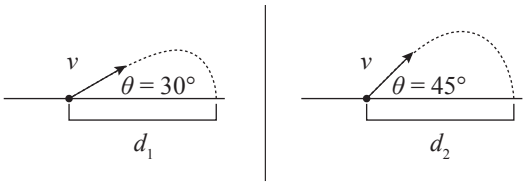
33. An empty mine car of mass m starts at rest at the top of a hill of height h above the ground, then rolls down the hill and into a semicircular banked turn. Ignoring rolling friction so that the only forces acting on the mine car are the normal force from the track and gravity, what is the magnitude of centripetal force on the car as it rounds the banked curve?

(A) mgh
(B) $2mgh/r$
(C) mgh/r
(D) $mgh/(2r)$



34. Five boxes are linked together, as shown above. If both the flat and slanted portions of the surface are frictionless, what will be the acceleration of the box marked B ?

(A) $\frac{1}{5}g\sin\theta$
(B) $\frac{2}{5}g\sin\theta$
(C) $\frac{5}{7}g\sin\theta$
(D) $\frac{2}{5}g\cos\theta$



35. If a ball is kicked at an angle of 30 degrees such that it has an initial velocity v, it will travel some distance, d_1, before falling back to the ground. Another ball is kicked at an angle of 45 degrees so that it also has an initial velocity of v, and it travels a distance, d_2, before falling back to the ground. How much farther will the second ball travel before striking the ground?

(A) $\frac{v^2}{10}(2-\sqrt{2})$
(B) $\frac{v^2}{10}(2-\sqrt{3})$
(C) $\frac{v^2}{20}(2-\sqrt{2})$
(D) $\frac{v^2}{20}(2-\sqrt{3})$

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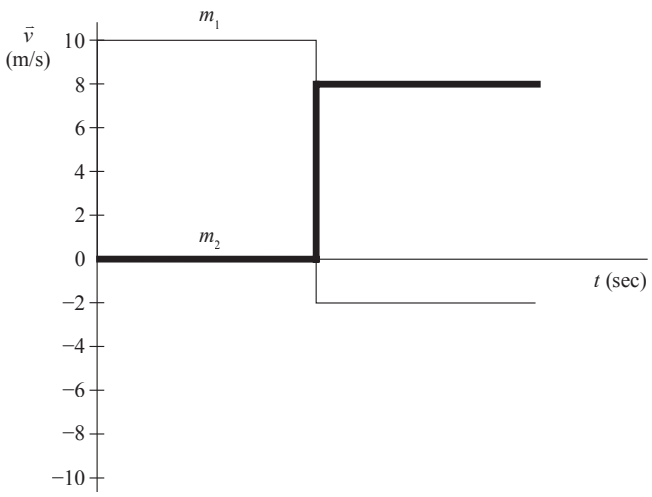


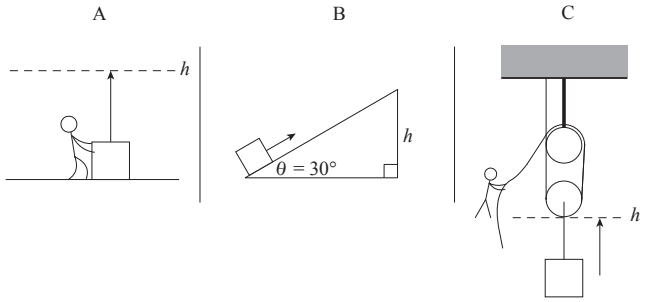
Questions 36–37 refer to the graph above.

36. Two objects of masses m_1 and m_2 undergo a collision. The graph above shows their velocities with respect to time both before and after the collision. If $m_1 = 10$ kg, then m_2 must be

(A) 5 kg
(B) 10 kg
(C) 15 kg
(D) 20 kg

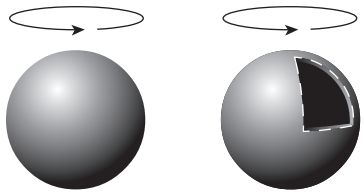
37. If the two objects have masses of $m_1 = 4$ kg and $m_2 = 6$ kg, what type of collision does the graph represent?

(A) Perfectly elastic
(B) Perfectly inelastic
(C) Neither of the above
(D) Cannot be determined



38. The diagrams above show a box of mass m being lifted from the ground up to a height of h via three different methods. In situation A, the box is simply lifted by a person. In B, it is pushed up a ramp with an incline angle of 30 degrees. In C, it is lifted by a pulley system. Assuming ideal conditions (no friction) for all of these situations, which of the following correctly ranks the amount of work required to lift the box in each case?

(A) A > B > C
(B) A > B = C
(C) C > B > A
(D) A = B = C



$m_1 = m_2$

$\tau_1 = \tau_2$

39. Two spheres of equal size and equal mass are rotated with an equal amount of torque. One of the spheres is solid with its mass evenly distributed throughout its volume, and the other is hollow with all of its mass concentrated at the edges. Which sphere would rotate faster?

(A) Solid sphere
(B) Hollow sphere
(C) They would rotate at equal rates.
(D) Additional information is required to determine the relative rates of rotation.

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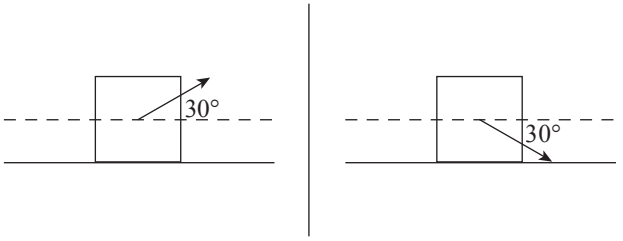
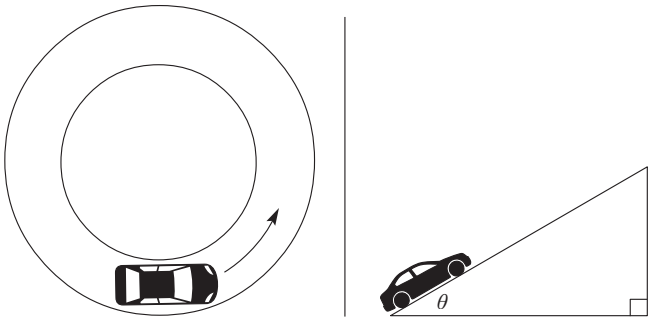


40. Pulling a block of mass m to the right by a connected string at an angle of 30 degrees above the horizontal (as shown in the left picture) with a force equal to the block's weight produces a friction force f. If the same block were to be pulled at an angle of 30 degrees beneath the horizontal (as shown in the right picture), what would be the friction force? Assume that the applied force is enough to make the block move in both cases.

(A) $3f$
(B) $2f$
(C) $f/2$
(D) $f/3$



top view side view

41. A car is driving in a circle of radius r at a constant speed v. At what angle must the road be banked in order to prevent sliding even if the road has no friction with the tires?

(A) $\tan^{-1}\frac{v^2}{rg}$

(B) $\tan^{-1}\frac{rg}{v^2}$

(C) $\cot^{-1}\frac{v^2}{rg}$

(D) $\cot^{-1}\frac{rg}{v^2}$

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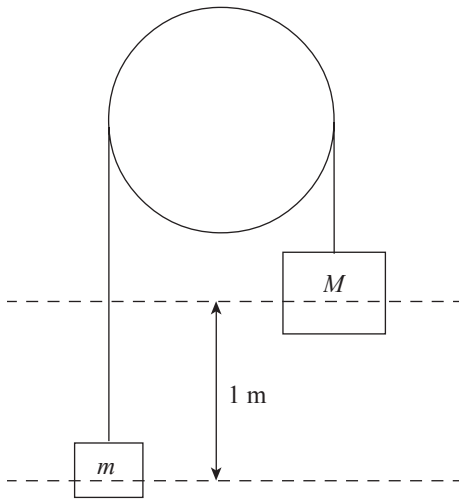


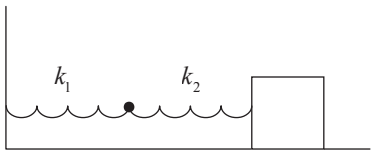
42. Assuming the pulley above is both frictionless and massless, how long will it take for the two blocks to reach an equal height if block *M* of mass 15 kg starts 1 m above block *m* of mass 5 kg?

(A) $\sqrt{\frac{2}{5}}$ s

(B) $\sqrt{\frac{1}{5}}$ s

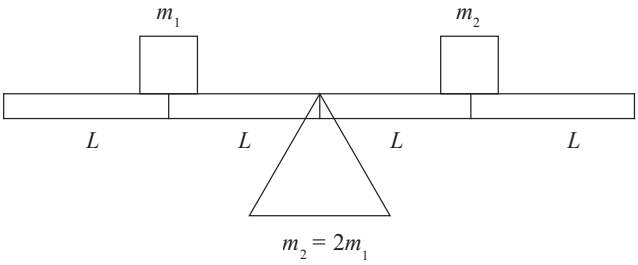
(C) $\sqrt{\frac{1}{20}}$ s

(D) $\frac{1}{5}$ s



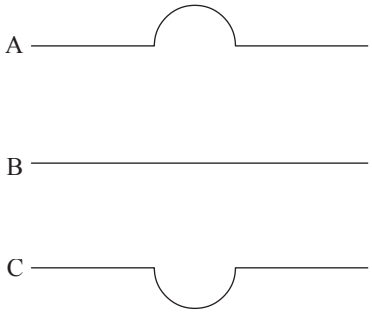
43. The spring-block system above has a block of mass *m* oscillating in simple harmonic motion. However, instead of one spring, there are two springs connected to each other. The first spring has a spring constant k_1, and the second has a spring constant k_2. What would be the effective spring constant of the system above if $k_2 = 3k_1$?

(A) $4k_1$
(B) $3k_1$
(C) $4k_1/3$
(D) $3k_1/4$



44. As it is, the system above is not balanced. Which of the following changes would NOT balance the system so that there is 0 net torque? Assume the plank has no mass of its own.

(A) Adding a mass equal to m_2 on the far left side and a mass equal to m_1 and on the far right side
(B) Stacking both masses directly on top of the fulcrum
(C) Moving the fulcrum a distance L/3 to the right
(D) Moving both masses a distance L/3 to the left



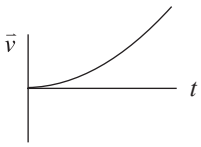
45. Three identical balls are rolled from left to right across the three tracks above with the same initial speed. Assuming the tracks all have negligible friction and the balls have enough initial speed to reach the ends of each track, which set correctly orders the average speed of the balls on the three tracks?

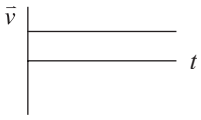
(A) A = B = C
(B) B > C > A
(C) C > B > A
(D) Cannot be determined

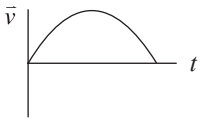
GO ON TO THE NEXT PAGE.

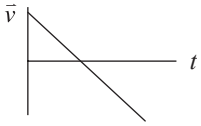
Directions: For each of the questions 46-50, two of the suggested answers will be correct. Select the two answers that are best in each case, and then fill in both of the corresponding circles on the answer sheet.

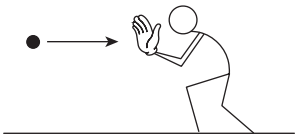
46. Which of the two velocity vs. time graphs depict situations of uniform accelerated motion? Select two answers.

(A) 

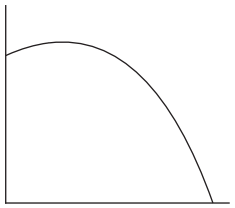
(B) 

(C) 

(D) 



47. A man is standing on a frictionless surface. A ball is thrown horizontally to him, and he catches it with his outstretched hand, as shown above. Which two of the following values will remain the same after the catch as they were before the catch? Select two answers.
    (A) Angular momentum of the man-and-ball system
    (B) Angular momentum of the ball about the man's center of mass
    (C) Mechanical energy of the man-and-ball system
    (D) Momentum of the man-and-ball system



48. The graph above could be a representation of which two of the following situations? Select two answers.
    (A) Vertical displacement vs. time as an object falls with no air resistance
    (B) Kinetic energy vs. time as an object falls with no air resistance
    (C) Kinetic energy vs. time as a rocket flies at constant speed but steadily burns fuel
    (D) Potential energy vs. time as an object falls with no air resistance

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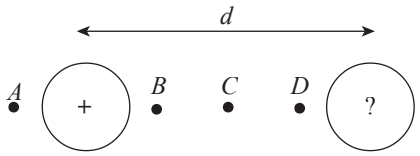
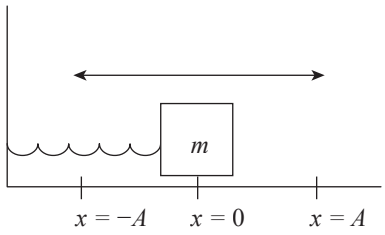


49. Two spheres are separated by a distance d. The first sphere has a known positive charge. The second sphere has a charge of a magnitude greater than the magnitude of the charge on the first sphere but unknown sign. Given this information, at which two of the above locations could a positive test charge potentially experience 0 net electrical force? Select two answers.

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



50. A spring-block system with a block of known mass m is oscillating under ideal conditions. Which two of the following pieces of additional sets of information would allow you to calculate the amplitude of the block's motion? Select two answers.

(A) The speed of the block at maximum displacement from equilibrium and the maximum potential energy of the system
(B) The spring constant and the period
(C) The period and the maximum kinetic energy of the system
(D) The maximum kinetic energy of the system and the spring constant

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.

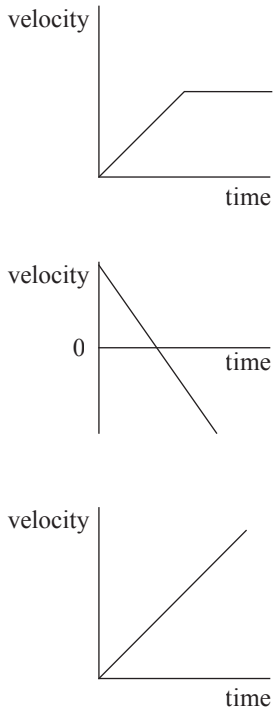
GO ON TO THE NEXT PAGE.

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 car of known mass m_1 will collide with a second car of known mass m_2. The collision will be head on, and both cars will only move linearly both before and after the collision. In a clear, coherent, paragraph-length response, explain a method for determining whether the collision is perfectly elastic, perfectly inelastic, or neither. If the collision is perfectly inelastic, include at least one possible cause of energy loss.



2. The three graphs above depict the velocity of different objects as functions of time. Given that information, draw potential displacement vs. time and acceleration vs. time graphs for each of them. Additionally, give an example of a situation that could produce each of the three graphs above.

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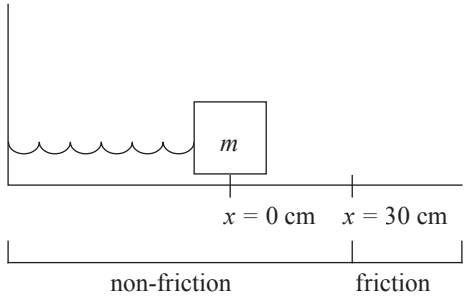
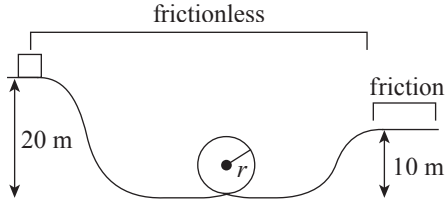


3. In the diagram above, a spring-block system is oscillating on a flat horizontal surface. Part of the surface is frictionless, and part of the surface is not frictionless. The block starts at rest at position $x = 0$ cm. The block is then pushed to the left, compressing the spring, until it reaches the position $x = -50$ cm. After being pushed in, the block is released and allowed to move naturally.

   (a) Draw a graph of the system's position as a function of time starting from the moment it is released and explain your reasoning behind the graph you draw. Be sure to label important values on the graph.

   (b) Given that the mass $m = 2$ kg and the spring constant $k = 100$ N/m, what is the magnitude of work done by the non-frictionless surface?



4. A roller coaster cart rides along the track shown above. The initial drop, the loop, and the ascending ramp are all frictionless. The flat portion of the track after the ascending ramp is not frictionless.

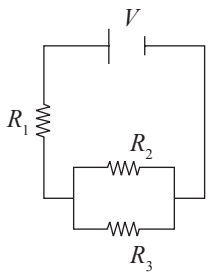
   (a) How fast would the cart be moving just before it enters the loop?

   (b) Would the normal force on the cart be greater just after entering the loop or at the peak of the loop? Explain why using relevant equations.

   (c) What is the greatest possible radius for the loop that would allow the cart to still make it through?

   (d) If the coefficient of static friction for the final segment of the track is 0.2, how long does the segment need to be in order to allow the cart to come to a complete stop due to friction alone?

GO ON TO THE NEXT PAGE.



5. The above circuit contains a battery of voltage V and three resistors with resistances R_1, R_2, and R_3, respectively. As part of an experiment, a student has been given two measuring devices: a voltmeter and an ammeter. The first can be used to measure the changes in voltage of a circuit. The second can be used to measure the current flowing through a particular segment of wire. For answering the questions below, a voltmeter and ammeter look like —(V)— and —(A)—, respectively, when drawn in a circuit diagram.

   (a) In terms of the known variables, what is the voltage lost in passing through the first resistor?

   (b) Draw a diagram showing how you would integrate the voltmeter to measure the voltage lost in the resistor labeled R_1. Explain the reasoning behind your decision.

   (c) Draw a diagram showing how you would integrate the ammeter to measure the current passing through the resistor labeled R_1. Explain the reasoning behind your decision.

   (d) What would be the ideal resistances for each device to have? Explain why each would be ideal for that device.

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
4	4	4	4	4	4
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

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28.	A	B	C	D	41.	A	B	C	D
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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					