PHYSICS C

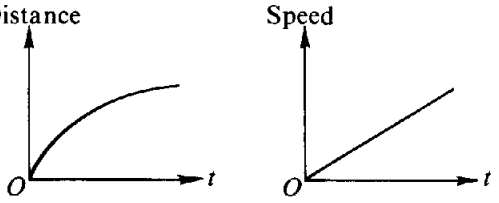
SECTION I, MECHANICS

Time—45 minutes

35 Questions

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

1. Which of the following pairs of graphs shows the distance traveled *versus* time and the speed *versus* time for an object uniformly accelerated from rest at time $t = 0$?

(A)


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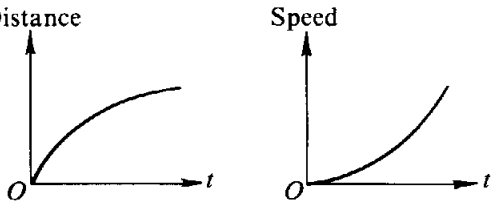
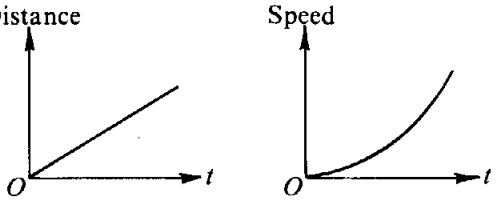


(C)


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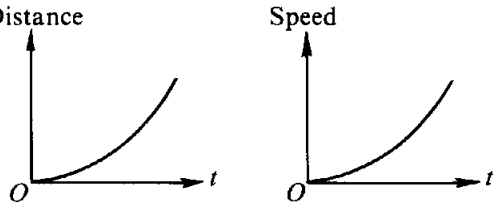
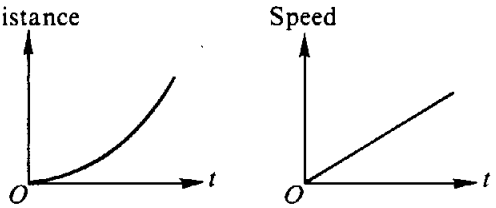
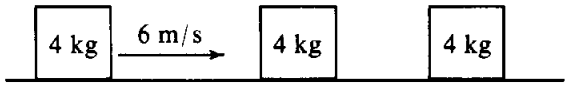


(E)


Questions 2-3



A 4-kilogram mass has a speed of 6 meters per second on a horizontal frictionless surface, as shown above. The mass collides head-on and elastically with an identical 4-kilogram mass initially at rest. The second 4-kilogram mass then collides head-on and sticks to a third 4-kilogram mass initially at rest.

2. The final speed of the first 4-kilogram mass is

(A) 0 m/s
(B) 2 m/s
(C) 3 m/s
(D) 4 m/s
(E) 6 m/s

3. The final speed of the two 4-kilogram masses that stick together is

(A) 0 m/s
(B) 2 m/s
(C) 3 m/s
(D) 4 m/s
(E) 6 m/s

4. A particle of mass m moves along a straight path with a speed v defined by the function $v = bt^2 + c$, where b and c are constants and t is time. What is the magnitude F of the net force on the particle at time $t = t_1$?

(A) $bt_1^2 + c$
(B) $3mbt_1 + 2c$
(C) mbt_1
(D) $mbt_1 + c$
(E) $2mbt_1$

GO ON TO THE NEXT PAGE

5. An object released from rest at time $t = 0$ slides down a frictionless incline a distance of 1 meter during the first second. The distance traveled by the object during the time interval from $t = 1$ second to $t = 2$ seconds is

   (A) 1 m
   (B) 2 m
   (C) 3 m
   (D) 4 m
   (E) 5 m

6. Two people are in a boat that is capable of a maximum speed of 5 kilometers per hour in still water, and wish to cross a river 1 kilometer wide to a point directly across from their starting point. If the speed of the water in the river is 5 kilometers per hour, how much time is required for the crossing?

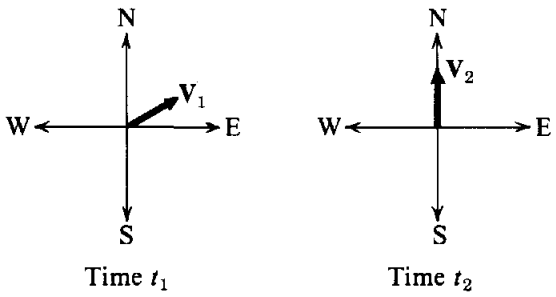
   (A) $\frac{1}{20}$ hr

   (B) $\frac{1}{10}$ hr

   (C) 1 hr

   (D) 10 hr

   (E) The point directly across from the starting point cannot be reached under these conditions.



7. Vectors V_1 and V_2 shown above have equal magnitudes. The vectors represent the velocities of an object at times t_1 and t_2, respectively. The average acceleration of the object between time t_1 and t_2 was

   (A) zero
   (B) directed north
   (C) directed west
   (D) directed north of east
   (E) directed north of west

8. A projectile of mass M_1 is fired horizontally from a spring gun that is initially at rest on a frictionless surface. The combined mass of the gun and projectile is M_2. If the kinetic energy of the projectile after firing is K, the gun will recoil with a kinetic energy equal to

   (A) K

   (B) $\frac{M_2}{M_1} K$

   (C) $\frac{M_1^2}{M_2^2} K$

   (D) $\frac{M_1}{M_2 - M_1} K$

   (E) $\sqrt{\frac{M_1}{M_2 - M_1}} K$

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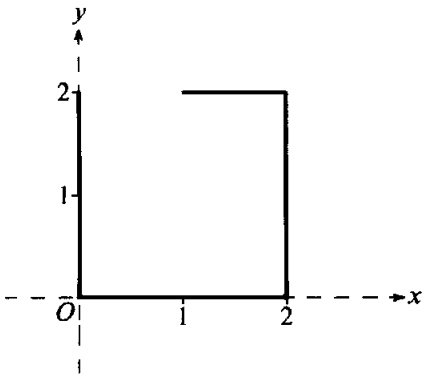


9. A piece of wire of uniform cross section is bent in the shape shown above. What are the coordinates $(\bar{x}, \bar{y})$ of the center of mass?

	$\bar{x}$	$\bar{y}$
(A)	15/14	6/7
(B)	6/7	6/7
(C)	15/14	8/7
(D)	1	1
(E)	1	6/7

10. A projectile is fired from the surface of the Earth with a speed of 200 meters per second at an angle of 30° above the horizontal. If the ground is level, what is the maximum height reached by the projectile?

(A) 5 m
(B) 10 m
(C) 500 m
(D) 1,000 m
(E) 2,000 m

11. A particle moves along the x-axis with a non-constant acceleration described by $a = 12t$, where a is in meters per second squared and t is in seconds. If the particle starts from rest so that its speed v and position x are zero when $t = 0$, where is it located when $t = 2$ seconds?

(A) $x = 12$ m
(B) $x = 16$ m
(C) $x = 24$ m
(D) $x = 32$ m
(E) $x = 48$ m

12. A figure skater is spinning on frictionless ice with her arms fully extended horizontally. She then drops her arms to her sides. Which of the following correctly describes her rotational kinetic energy and angular momentum as her arms fall?

	Rotational Kinetic Energy	Angular Momentum
(A)	Remains constant	Remains constant
(B)	Decreases	Increases
(C)	Decreases	Decreases
(D)	Increases	Decreases
(E)	Increases	Remains constant

GO ON TO THE NEXT PAGE

13. A ball is dropped from a height of 10 meters onto a hard surface so that the collision at the surface may be assumed elastic. Under such conditions the motion of the ball is

    (A) simple harmonic with a period of about 1.4 s
    (B) simple harmonic with a period of about 2.8 s
    (C) simple harmonic with an amplitude of 5 m
    (D) periodic with a period of about 2.8 s but not simple harmonic
    (E) motion with constant momentum

Questions 14-15

An object moving in a straight line has a velocity v in meters per second that varies with time t in seconds according to the following function.

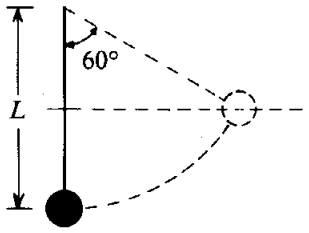
$$v = 4 + 0.5\,t^2$$

14. The instantaneous acceleration of the object at $t = 2$ seconds is

    (A) 2 m/s^2
    (B) 4 m/s^2
    (C) 5 m/s^2
    (D) 6 m/s^2
    (E) 8 m/s^2

15. The displacement of the object between $t = 0$ and $t = 6$ seconds is

    (A) 22 m
    (B) 28 m
    (C) 40 m
    (D) 42 m
    (E) 60 m



16. A pendulum consists of a ball of mass m suspended at the end of a massless cord of length L as shown above. The pendulum is drawn aside through an angle of 60° with the vertical and released. At the low point of its swing, the speed of the pendulum ball is

    (A) $\sqrt{gL}$
    (B) $\sqrt{2gL}$
    (C) $\frac{1}{2}gL$
    (D) gL
    (E) $2gL$

17. A rock is lifted for a certain time by a force F that is greater in magnitude than the rock's weight W. The change in kinetic energy of the rock during this time is equal to the

    (A) work done by the net force $(F - W)$
    (B) work done by F alone
    (C) work done by W alone
    (D) difference in the momentum of the rock before and after this time
    (E) difference in the potential energy of the rock before and after this time

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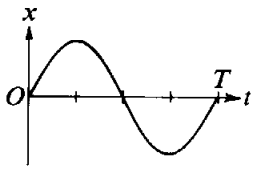
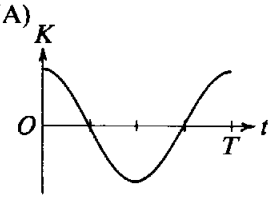
Questions 18-19 refer to the graph below of the displacement x *versus* time t for a particle in simple harmonic motion.



18. Which of the following graphs shows the kinetic energy K of the particle as a function of time t for one cycle of motion?

(A)


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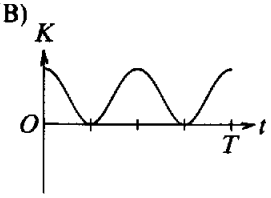

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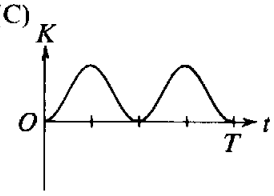
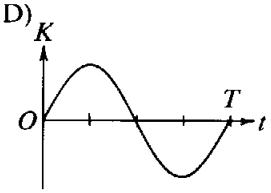
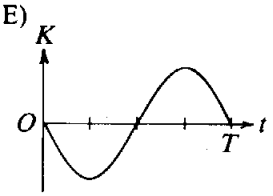
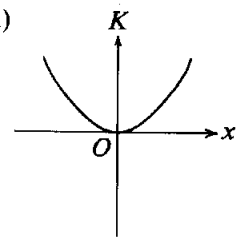
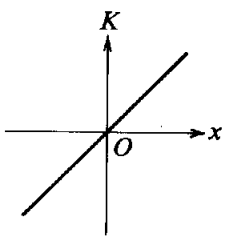


(D)


(E)


19. Which of the following graphs shows the kinetic energy K of the particle as a function of its displacement x?

(A)


(B)


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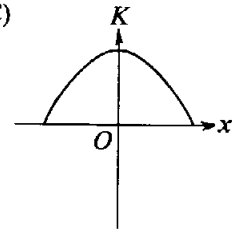
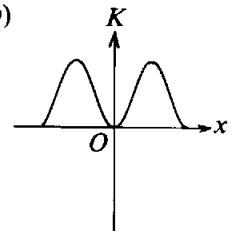


(D)


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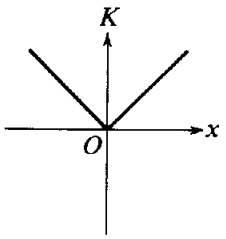

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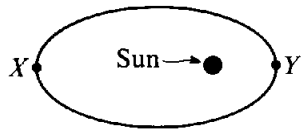


20. A satellite travels around the Sun in an elliptical orbit as shown above. As the satellite travels from point X to point Y, which of the following is true about its speed and angular momentum?

	Speed	Angular Momentum
(A)	Remains constant	Remains constant
(B)	Increases	Increases
(C)	Decreases	Decreases
(D)	Increases	Remains constant
(E)	Decreases	Remains constant

21. A newly discovered planet, "Cosmo," has a mass that is 4 times the mass of the Earth. The radius of the Earth is R_e. The gravitational field strength at the surface of Cosmo is equal to that at the surface of the Earth if the radius of Cosmo is equal to

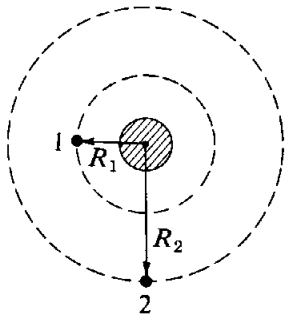
(A) $\frac{1}{2} R_e$

(B) R_e

(C) $2R_e$

(D) $\sqrt{R_e}$

(E) $R_e{}^2$



22. Two artificial satellites, 1 and 2, orbit the Earth in circular orbits having radii R_1 and R_2, respectively, as shown above. If $R_2 = 2R_1$, the accelerations a_2 and a_1 of the two satellites are related by which of the following?

(A) $a_2 = 4a_1$

(B) $a_2 = 2a_1$

(C) $a_2 = a_1$

(D) $a_2 = \frac{a_1}{2}$

(E) $a_2 = \frac{a_1}{4}$

GO ON TO THE NEXT PAGE

23. A bowling ball of mass M and radius R, whose moment of inertia about its center is $\frac{2}{5}MR^2$, rolls without slipping along a level surface at speed v. The maximum vertical height to which it can roll if it ascends an incline is

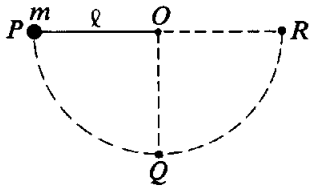
(A) $\frac{1}{5}\frac{v^2}{g}$

(B) $\frac{2}{5}\frac{v^2}{g}$

(C) $\frac{1}{2}\frac{v^2}{g}$

(D) $\frac{7}{10}\frac{v^2}{g}$

(E) $\frac{v^2}{g}$



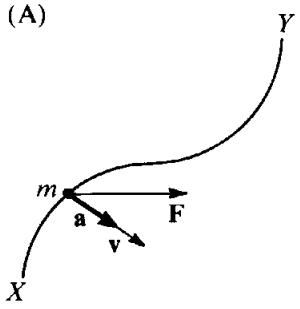
24. A ball of mass m is attached to the end of a string of length ℓ as shown above. The ball is released from rest from position P, where the string is horizontal. It swings through position Q, where the string is vertical, and then to position R, where the string is again horizontal. What are the directions of the acceleration vectors of the ball at positions Q and R?

	Position Q	Position R
(A)	Downward	Downward
(B)	Downward	To the right
(C)	Upward	Downward
(D)	Upward	To the left
(E)	To the right	To the left

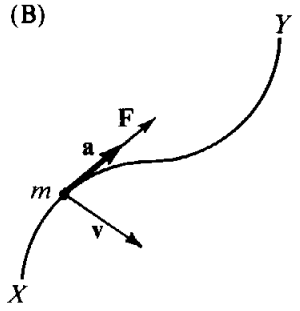
GO ON TO THE NEXT PAGE

25. A mass m moves on a curved path from point X to point Y. Which of the following diagrams indicates a possible combination of the net force **F** on the mass, and the velocity **v** and acceleration **a** of the mass at the location shown?

(A)



(B)



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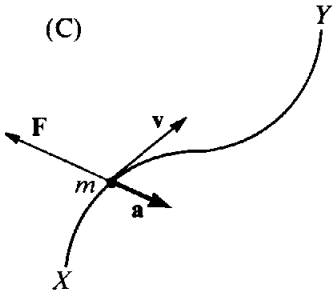
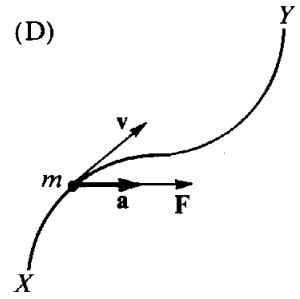


(D)



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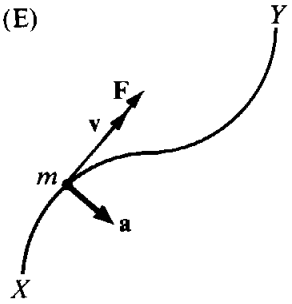

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Questions 26-27

A particle moves in a circle in such a way that the x- and y-coordinates of its motion are given in meters as functions of time t in seconds by:

$$x = 5\cos(3t)$$
$$y = 5\sin(3t)$$

26. What is the period of revolution of the particle?

(A) $\frac{1}{3}$ s

(B) 3 s

(C) $\frac{2\pi}{3}$ s

(D) $\frac{3\pi}{2}$ s

(E) 6π s

27. Which of the following is true of the speed of the particle?

(A) It is always equal to 5 m/s.
(B) It is always equal to 15 m/s.
(C) It oscillates between 0 and 5 m/s.
(D) It oscillates between 0 and 15 m/s.
(E) It oscillates between 5 and 15 m/s.

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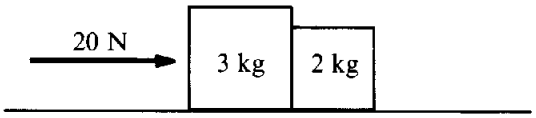
28. The radius of the Earth is approximately 6,000 kilometers. The acceleration of an astronaut in a perfectly circular orbit 300 kilometers above the Earth would be most nearly

(A) 0 m/s^2
(B) 0.05 m/s^2
(C) 5 m/s^2
(D) 9 m/s^2
(E) 11 m/s^2



29. Two blocks are pushed along a horizontal frictionless surface by a force of 20 newtons to the right, as shown above. The force that the 2-kilogram block exerts on the 3-kilogram block is

(A) 8 newtons to the left
(B) 8 newtons to the right
(C) 10 newtons to the left
(D) 12 newtons to the right
(E) 20 newtons to the left

30. When a mass m is hung on a certain ideal spring, the spring stretches a distance d. If the mass is then set oscillating on the spring, the period of oscillation is proportional to

(A) $\sqrt{\frac{d}{g}}$

(B) $\sqrt{\frac{g}{d}}$

(C) $\sqrt{\frac{d}{mg}}$

(D) $\sqrt{\frac{m^2g}{d}}$

(E) $\sqrt{\frac{m}{g}}$

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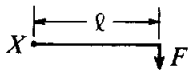
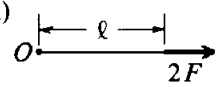
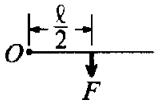
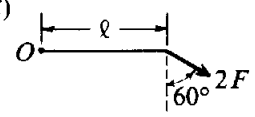


31. In which of the following diagrams is the torque about point O equal in magnitude to the torque about point X in the diagram above? (All forces lie in the plane of the paper.)

(A)


(B)


(C)


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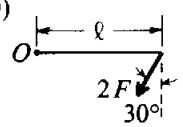

(E) None of the above

32. A 10-kilogram body is constrained to move along the x-axis. The potential energy U of the body in joules is given as a function of its position x in meters by

$$U(x) = 6x^2 - 4x + 3$$

The force on the particle at $x = 3$ meters is

(A) 32 N in $+x$ direction
(B) 32 N in $-x$ direction
(C) 45 N in $+x$ direction
(D) 45 N in $-x$ direction
(E) 98 N in $+x$ direction

33. A rock is dropped from the top of a 45-meter tower, and at the same time a ball is thrown from the top of the tower in a horizontal direction. Air resistance is negligible. The ball and the rock hit the level ground a distance of 30 meters apart. The horizontal velocity of the ball thrown was most nearly

(A) 5 m/s
(B) 10 m/s
(C) 14.1 m/s
(D) 20 m/s
(E) 28.3 m/s

34. Two objects of equal mass hang from independent springs of unequal spring constant and oscillate up and down. The spring of greater spring constant must have the

(A) smaller amplitude of oscillation
(B) larger amplitude of oscillation
(C) shorter period of oscillation
(D) longer period of oscillation
(E) lower frequency of oscillation

35. A satellite moves in a stable circular orbit with speed v_0 at a distance R from the center of a planet. For this satellite to move in a stable circular orbit a distance $2R$ from the center of the planet, the speed of the satellite must be

(A) $\frac{v_0}{2}$

(B) $\frac{v_0}{\sqrt{2}}$

(C) v_0

(D) $\sqrt{2v_0}$

(E) $2v_0$

END OF SECTION I, MECHANICS

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON SECTION I, MECHANICS, ONLY.
DO NOT TURN TO ANY OTHER TEST MATERIALS.

ANSWER KEY AND PERCENT ANSWERING CORRECTLY
SECTION I
1988 AP Physics C Examination: Mechanics

Listed below are the correct answers to the multiple-choice questions and the percentage of AP candidates who attempted each question and answered it correctly. As a general rule, candidates who correctly answered an individual question also achieved a higher mean score on the test as a whole than did candidates who did not answer that question correctly.

Item No.	Correct Answer	Percent Correct	Item No.	Correct Answer	Percent Correct
1	E	78%	19	C	48%
2	A	55%	20	D	54%
3	C	70%	21	C	69%
4	E	86%	22	E	36%
5	C	43%	23	D	31%
6	E	55%	24	C	27%
7	E	50%	25	D	56%
8	D	31%	26	C	55%
9	A	55%	27	B	27%
10	C	67%	28	D	34%
11	B	73%	29	A	53%
12	E	70%	30	A	33%
13	D	28%	31	C	62%
14	A	92%	32	B	33%
15	E	84%	33	B	66%
16	A	63%	34	C	41%
17	A	43%	35	B	41%
18	B	51%			

A sample answer sheet gridded with the correct responses for the 1988 AP Physics C Examination appears on page 83.

ANSWER KEY AND PERCENT ANSWERING CORRECTLY
SECTION I
1988 AP Physics C Examination: Electricity and Magnetism

Listed below are the correct answers to the multiple-choice questions and the percentage of AP candidates who attempted each question and answered it correctly. As a general rule, candidates who correctly answered an individual question also achieved a higher mean score on the test as a whole than did candidates who did not answer that question correctly.

Item No.	Correct Answer	Percent Correct	Item No.	Correct Answer	Percent Correct
36	E	51%	54	C	66%
37	E	22%	55	B	37%
38	D	51%	56	A	37%
39	E	67%	57	D	74%
40	A	76%	58	E	45%
41	D	31%	59	B	53%
42	E	57%	60	A	32%
43	D	72%	61	C	41%
44	D	60%	62	A	45%
45	A	54%	63	C	38%
46	B	60%	64	B	45%
47	A	78%	65	D	29%
48	C	62%	66	B	65%
49	B	69%	67	B	41%
50	E	50%	68	D	34%
51	E	29%	69	C	51%
52	E	72%	70	B	50%
53	B	48%			

A sample answer sheet gridded with the correct responses for the 1988 AP Physics C Examination appears on the next page.