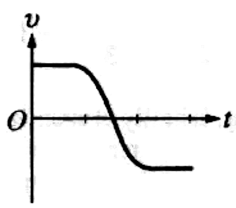
PHYSICS C
Section I, MECHANICS
Time—45 minutes
35 Questions

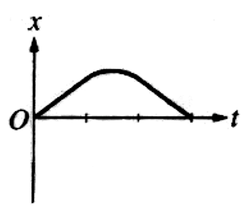
Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

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

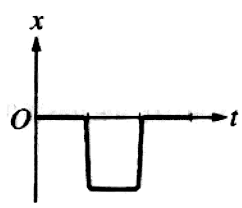


1. The graph above shows velocity v *versus* time t for an object in linear motion. Which of the following is a possible graph of position x *versus* time t for this object?

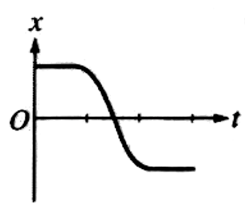
(A)



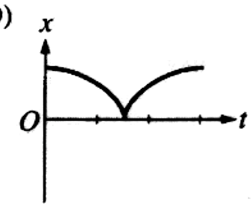
(B)



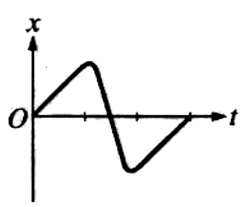
(C)



(D)

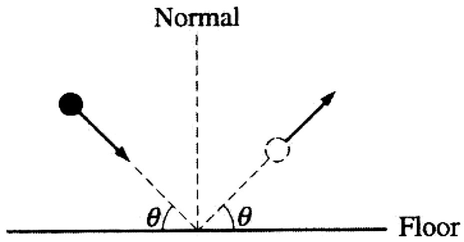


(E)



2. An object is dropped from rest from the top of a 400 m cliff on Earth. If air resistance is negligible, what is the distance the object travels during the first 6 s of its fall?

(A) 30 m
(B) 60 m
(C) 120 m
(D) 180 m
(E) 360 m



3. A 2 kg ball collides with the floor at an angle θ and rebounds at the same angle and speed as shown above. Which of the following vectors represents the impulse exerted on the ball by the floor?

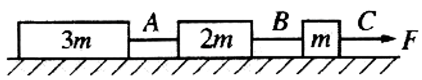
(A) 

(B) 

(C)

(D) 

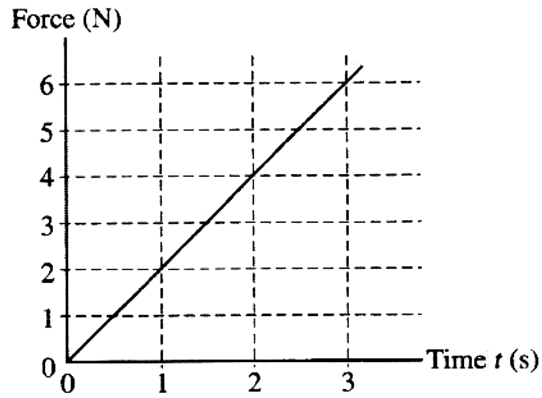
(E) 



4. Three blocks of masses $3m$, $2m$, and m are connected to strings A, B, and C as shown above. The blocks are pulled along a rough surface by a force of magnitude F exerted by string C. The coefficient of friction between each block and the surface is the same. Which string must be the strongest in order not to break?

(A) A
(B) B
(C) C
(D) They must all be the same strength.
(E) It is impossible to determine without knowing the coefficient of friction.

Questions 5-6



A block of mass 3 kg, initially at rest, is pulled along a frictionless, horizontal surface with a force shown as a function of time t by the graph above.

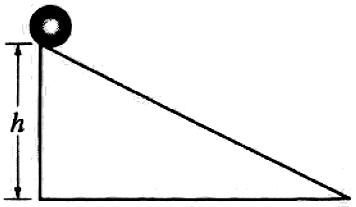
5. The acceleration of the block at $t = 2$ s is

(A) 3/4 m/s^2
(B) 4/3 m/s^2
(C) 2 m/s^2
(D) 8 m/s^2
(E) 12 m/s^2

6. The speed of the block at $t = 2$ s is

(A) 4/3 m/s
(B) 8/3 m/s
(C) 4 m/s
(D) 8 m/s
(E) 24 m/s

Questions 7-8



A sphere of mass M, radius r, and rotational inertia I is released from rest at the top of an inclined plane of height h as shown above.

7. If the plane is frictionless, what is the speed v_{cm} of the center of mass of the sphere at the bottom of the incline?

(A) $\sqrt{2gh}$

(B) $\frac{2Mgh}{I}$

(C) $\frac{2Mghr^2}{I}$

(D) $\sqrt{\frac{2Mghr^2}{I}}$

(E) $\sqrt{\frac{2Mghr^2}{I + Mr^2}}$

8. If the plane has friction so that the sphere rolls without slipping, what is the speed v_{cm} of the center of mass at the bottom of the incline?

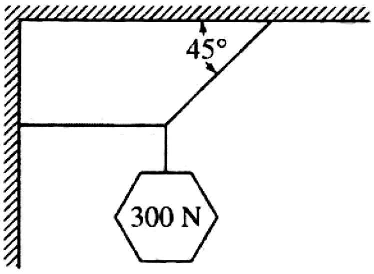
(A) $\sqrt{2gh}$

(B) $\frac{2Mgh}{I}$

(C) $\frac{2Mghr^2}{I}$

(D) $\sqrt{\frac{2Mghr^2}{I}}$

(E) $\sqrt{\frac{2Mghr^2}{I + Mr^2}}$



9. An object weighing 300 N is suspended by means of two cords, as shown above. The tension in the horizontal cord is

(A) 0 N
(B) 150 N
(C) 210 N
(D) 300 N
(E) 400 N

Questions 10-12

A small box is on a ramp tilted at an angle θ above the horizontal. The box may be subject to the following forces: frictional (f), gravitational (mg), pulling or pushing (F_p) and normal (N). In the following free-body diagrams for the box, the lengths of the vectors are proportional to the magnitudes of the forces.

Figure A

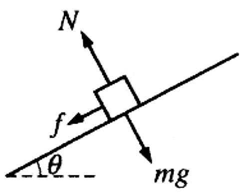


Figure B

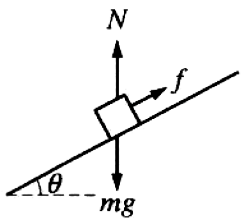


Figure C

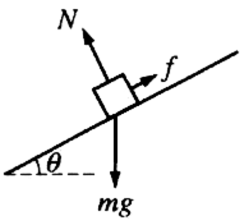


Figure D

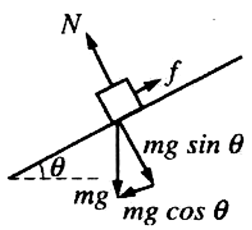
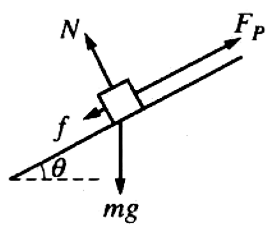


Figure E



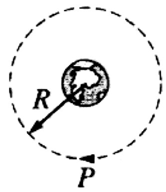
10. Which figure best represents the free-body diagram for the box if it is accelerating up the ramp?
    (A) Figure A
    (B) Figure B
    (C) Figure C
    (D) Figure D
    (E) Figure E

11. Which figure best represents the free-body diagram for the box if it is at rest on the ramp?
    (A) Figure A
    (B) Figure B
    (C) Figure C
    (D) Figure D
    (E) Figure E

12. Which figure best represents the free-body diagram for the box if it is sliding down the ramp at constant speed?
    (A) Figure A
    (B) Figure B
    (C) Figure C
    (D) Figure D
    (E) Figure E

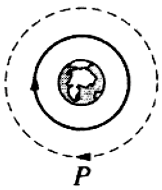
---

13. The momentum p of a moving object as a function of time t is given by the expression $p = kt^3$, where k is a constant. The force causing this motion is given by the expression
    (A) $3kt^2$
    (B) $\frac{3kt^2}{2}$
    (C) $\frac{kt^2}{3}$
    (D) kt^4
    (E) $\frac{kt^4}{4}$

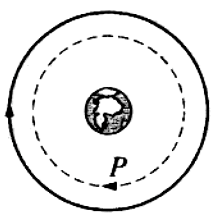


14. A spacecraft orbits Earth in a circular orbit of radius R, as shown above. When the spacecraft is at position P shown, a short burst of the ship's engines results in a small increase in its speed. The new orbit is best shown by the solid curve in which of the following diagrams?

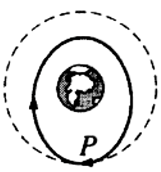
(A)



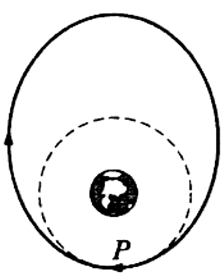
(B)



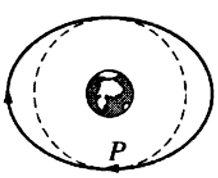
(C)



(D)



(E)

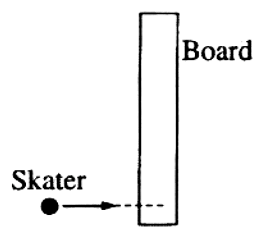


15. A student holds one end of a string in a fixed position. A ball of mass 0.2 kg attached to the other end of the string moves in a horizontal circle of radius 0.5 m with a constant speed of 5 m/s. How much work is done on the ball by the string during each revolution?

(A) 0 J
(B) 0.5 J
(C) 1.0 J
(D) 2π J
(E) 5π J

16. A wheel of 0.5 m radius rolls without slipping on a horizontal surface. The axle of the wheel advances at constant velocity, moving a distance of 20 m in 5 s. The angular speed of the wheel about its point of contact on the surface is

(A) 2 radians $\cdot$ s^{-1}
(B) 4 radians $\cdot$ s^{-1}
(C) 8 radians $\cdot$ s^{-1}
(D) 16 radians $\cdot$ s^{-1}
(E) 32 radians $\cdot$ s^{-1}



Top View

17. A long board is free to slide on a sheet of frictionless ice. As shown in the top view above, a skater skates to the board and hops onto one end, causing the board to slide and rotate. In this situation, which of the following occurs?

(A) Linear momentum is converted to angular momentum.
(B) Kinetic energy is converted to angular momentum.
(C) Rotational kinetic energy is conserved.
(D) Translational kinetic energy is conserved.
(E) Linear momentum and angular momentum are both conserved.

Questions 18-19

A simple pendulum has a period of 2 s for small amplitude oscillations.

18. The length of the pendulum is most nearly

(A) 1/6 m
(B) 1/4 m
(C) 1/2 m
(D) 1 m
(E) 2 m

19. Which of the following equations could represent the angle θ that the pendulum makes with the vertical as a function of time t ?

(A) $\theta = \theta_{max} \sin \frac{\pi}{2} t$

(B) $\theta = \theta_{max} \sin \pi t$

(C) $\theta = \theta_{max} \sin 2\pi t$

(D) $\theta = \theta_{max} \sin 4\pi t$

(E) $\theta = \theta_{max} \sin 8\pi t$

20. Two blocks of masses M and m, with $M > m$, are connected by a light string. The string passes over a frictionless pulley of negligible mass so that the blocks hang vertically. The blocks are then released from rest. What is the acceleration of the block of mass M ?

(A) g

(B) $\frac{M - m}{M} g$

(C) $\frac{M + m}{M} g$

(D) $\frac{M + m}{M - m} g$

(E) $\frac{M - m}{M + m} g$

21. For a particular nonlinear spring, the relationship between the magnitude of the applied force F and the resultant displacement x from equilibrium is given by the equation $F = kx^2$. What is the amount of work done by stretching the spring a distance x_0 ?

(A) kx_0^3

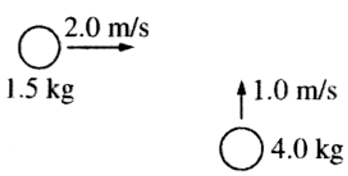
(B) $\frac{1}{2} kx_0$

(C) $\frac{1}{2} kx_0^3$

(D) $\frac{1}{3} kx_0^2$

(E) $\frac{1}{3} kx_0^3$

Questions 22-23



Two pucks moving on a frictionless air table are about to collide, as shown above. The 1.5 kg puck is moving directly east at 2.0 m/s. The 4.0 kg puck is moving directly north at 1.0 m/s.

22. What is the total kinetic energy of the two-puck system before the collision?

(A) $\sqrt{13}$ J
(B) 5.0 J
(C) 7.0 J
(D) 10 J
(E) 11 J

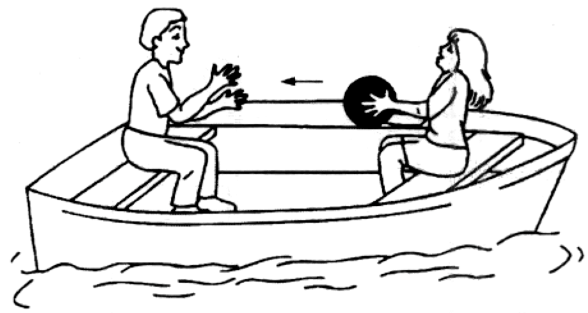
23. What is the magnitude of the total momentum of the two-puck system after the collision?

(A) 1.0 kg·m/s
(B) 3.5 kg·m/s
(C) 5.0 kg·m/s
(D) 7.0 kg·m/s
(E) $5.5\sqrt{5}$ kg·m/s

---

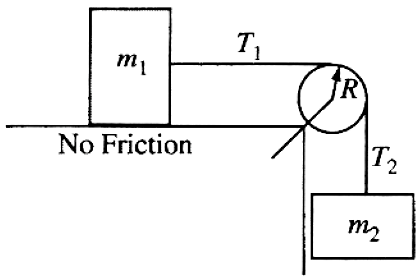
24. The position of an object is given by the equation $x = 3.0t^2 + 1.5t + 4.5$, where x is in meters and t is in seconds. What is the instantaneous acceleration of the object at $t = 3.0$ s?

(A) 3.0 m/s^2
(B) 6.0 m/s^2
(C) 9.0 m/s^2
(D) 19.5 m/s^2
(E) 36 m/s^2



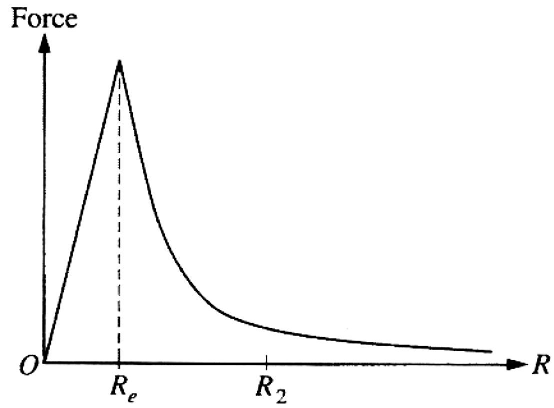
25. As shown above, two students sit at opposite ends of a boat that is initially at rest. The student in the front throws a heavy ball to the student in the back. What is the motion of the boat at the time immediately after the ball is thrown and, later, after the ball is caught? (Assume that air and water friction are negligible.)

	Immediately After the Throw	After the Catch
(A)	Boat moves forward	Boat moves forward
(B)	Boat moves forward	Boat moves backward
(C)	Boat moves forward	Boat does not move
(D)	Boat moves backward	Boat does not move
(E)	Boat moves backward	Boat moves forward



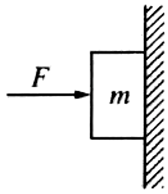
26. Two blocks are joined by a light string that passes over the pulley shown above, which has radius R and moment of inertia I about its center. T_1 and T_2 are the tensions in the string on either side of the pulley and α is the angular acceleration of the pulley. Which of the following equations best describes the pulley's rotational motion during the time the blocks accelerate?

(A) $m_2 gR = I\alpha$
(B) $(T_1 + T_2)R = I\alpha$
(C) $T_2 R = I\alpha$
(D) $(T_2 - T_1)R = I\alpha$
(E) $(m_2 - m_1)gR = I\alpha$



27. The graph above shows the force of gravity on a small mass as a function of its distance R from the center of the Earth of radius R_e, if the Earth is assumed to have a uniform density. The work done by the force of gravity when the small mass approaches Earth from far away and is placed into a circular orbit of radius R_2 is best represented by the area under the curve between

(A) $R = 0$ and $R = R_e$
(B) $R = 0$ and $R = R_2$
(C) $R = R_e$ and $R = R_2$
(D) $R = R_e$ and $R = \infty$
(E) $R = R_2$ and $R = \infty$



28. A horizontal force F pushes a block of mass m against a vertical wall. The coefficient of friction between the block and the wall is μ. What value of F is necessary to keep the block from slipping down the wall?

(A) mg

(B) μmg

(C) $\frac{mg}{\mu}$

(D) $mg(1-\mu)$

(E) $mg(1+\mu)$

29. A mass M suspended by a spring with force constant k has a period T when set into oscillation on Earth. Its period on Mars, whose mass is about $\frac{1}{9}$ and radius $\frac{1}{2}$ that of Earth, is most nearly

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

(B) $\frac{2}{3}T$

(C) T

(D) $\frac{3}{2}T$

(E) $3T$

30. A 1000 W electric motor lifts a 100 kg safe at constant velocity. The vertical distance through which the motor can raise the safe in 10 s is most nearly

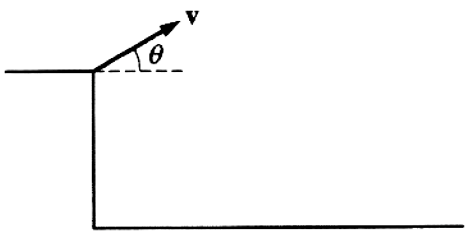
(A) 1 m
(B) 3 m
(C) 10 m
(D) 32 m
(E) 100 m

31. A 1.0 kg mass is attached to the end of a vertical ideal spring with a force constant of 400 N/m. The mass is set in simple harmonic motion with an amplitude of 10 cm. The speed of the 1.0 kg mass at the equilibrium position is

(A) 2 m/s
(B) 4 m/s
(C) 20 m/s
(D) 40 m/s
(E) 200 m/s

32. A student is testing the kinematic equations for uniformly accelerated motion by measuring the time it takes for light-weight plastic balls to fall to the floor from a height of 3 m in the lab. The student predicts the time to fall using g as $9.80\ \text{m/s}^2$ but finds the measured time to be 35% greater. Which of the following is the most likely cause of the large percent error?

(A) The acceleration due to gravity is 70% greater than $9.80\ \text{m/s}^2$ at this location.
(B) The acceleration due to gravity is 70% less than $9.80\ \text{m/s}^2$ at this location.
(C) Air resistance increases the downward acceleration.
(D) The acceleration of the plastic balls is not uniform.
(E) The plastic balls are not truly spherical.



Note: Figure not drawn to scale.

33. An object is thrown with velocity **v** from the edge of a cliff above level ground. Neglect air resistance. In order for the object to travel a maximum horizontal distance from the cliff before hitting the ground, the throw should be at an angle θ with respect to the horizontal of

    (A) greater than 60° above the horizontal
    (B) greater than 45° but less than 60° above the horizontal
    (C) greater than zero but less than 45° above the horizontal
    (D) zero
    (E) greater than zero but less than 45° below the horizontal

34. A car travels forward with constant velocity. It goes over a small stone, which gets stuck in the groove of a tire. The initial acceleration of the stone, as it leaves the surface of the road, is

    (A) vertically upward
    (B) horizontally forward
    (C) horizontally backward
    (D) zero
    (E) upward and forward, at approximately 45° to the horizontal

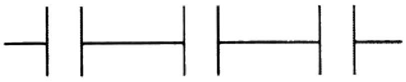
35. The escape speed for a rocket at Earth's surface is v_e. What would be the rocket's escape speed from the surface of a planet with twice Earth's mass and the same radius as Earth?

    (A) $2v_e$
    (B) $\sqrt{2}v_e$
    (C) v_e
    (D) $\dfrac{v_e}{\sqrt{2}}$
    (E) $\dfrac{v_e}{2}$

END OF SECTION I, MECHANICS

PHYSICS C
Section I, ELECTRICITY AND MAGNETISM
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.



36. Three $\frac{1}{2}$ μF capacitors are connected in series as shown in the diagram above. The capacitance of the combination is

(A) $\frac{3}{2}$ μF

(B) 1 μF

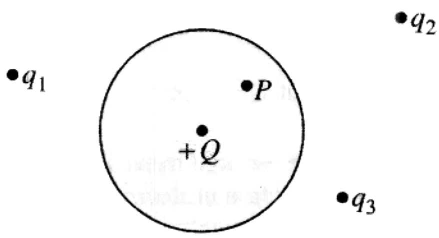
(C) $\frac{2}{3}$ μF

(D) $\frac{1}{2}$ μF

(E) $\frac{1}{6}$ μF

37. A hair dryer is rated as 1200 W, 120 V. Its effective internal resistance is

(A) 0.1 Ω
(B) 10 Ω
(C) 12 Ω
(D) 120 Ω
(E) 1440 Ω



38. A point charge $+Q$ is inside an uncharged conducting spherical shell that in turn is near several isolated point charges, as shown above. The electric field at point P inside the shell depends on the magnitude of

(A) Q only
(B) the charge distribution on the sphere only
(C) Q and the charge distribution on the sphere
(D) all of the point charges
(E) all of the point charges and the charge distribution on the sphere

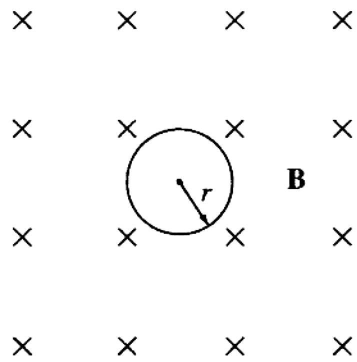
39. In a certain region, the electric field along the x-axis is given by

$E = ax + b$, where $a = 40\ \text{V/m}^2$ and $b = 4\ \text{V/m}$.

The potential difference between the origin and $x = 0.5$ m is

(A) −36 V
(B) −7 V
(C) −3 V
(D) 10 V
(E) 16 V

Questions 40-41



A particle of charge $+e$ and mass m moves with speed v perpendicular to a uniform magnetic field **B** directed into the page. The path of the particle is a circle of radius r, as shown above.

40. Which of the following correctly gives the direction of motion and the equation relating v and r?

	Direction	Equation
(A)	Clockwise	$eBr = mv$
(B)	Clockwise	$eBr = mv^2$
(C)	Counterclockwise	$eBr = mv$
(D)	Counterclockwise	$eBr = mv^2$
(E)	Counterclockwise	$eBr^2 = mv^2$

41. The period of revolution of the particle is

(A) $\frac{mr}{eB}$

(B) $\sqrt{\frac{m}{eB}}$

(C) $\frac{2\pi m}{eB}$

(D) $2\pi\sqrt{\frac{m}{eB}}$

(E) $2\pi\sqrt{\frac{mr}{eB}}$

42. A 20 μF parallel-plate capacitor is fully charged to 30 V. The energy stored in the capacitor is most nearly

(A) 9×10^3 J
(B) 9×10^{-3} J
(C) 6×10^{-4} J
(D) 2×10^{-4} J
(E) 2×10^{-7} J

43. A potential difference V is maintained between two large, parallel conducting plates. An electron starts from rest on the surface of one plate and accelerates toward the other. Its speed as it reaches the second plate is proportional to

(A) $1/V$
(B) $1/\sqrt{V}$
(C) $\sqrt{V}$
(D) V
(E) V^2

44. A wire of radius R has a current I uniformly distributed across its cross-sectional area. Ampere's law is used with a concentric circular path of radius r, with $r < R$, to calculate the magnitude of the magnetic field B at a distance r from the center of the wire. Which of the following equations results from a correct application of Ampere's law to this situation?

(A) $B(2\pi r) = \mu_0 I$

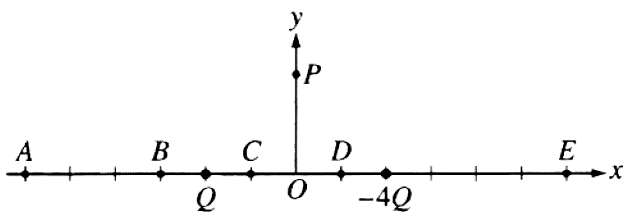
(B) $B(2\pi r) = \mu_0 I\left(\frac{r^2}{R^2}\right)$

(C) $B(2\pi r) = 0$

(D) $B(2\pi R) = \mu_0 I$

(E) $B(2\pi R) = \mu_0 I\left(\frac{r^2}{R^2}\right)$

Questions 45-46



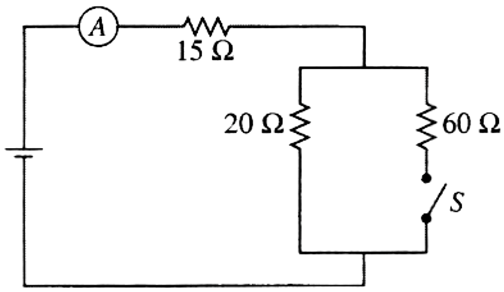
Particles of charge Q and $-4Q$ are located on the x-axis as shown in the figure above. Assume the particles are isolated from all other charges.

45. Which of the following describes the direction of the electric field at point P ?

(A) $+x$
(B) $+y$
(C) $-y$
(D) Components in both the $-x$- and $+y$-directions
(E) Components in both the $+x$- and $-y$-directions

46. At which of the labeled points on the x-axis is the electric field zero?

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



47. When the switch S is open in the circuit shown above, the reading on the ammeter A is 2.0 A. When the switch is closed, the reading on the ammeter is

(A) doubled
(B) increased slightly but not doubled
(C) the same
(D) decreased slightly but not halved
(E) halved

48. Two conducting cylindrical wires are made out of the same material. Wire X has twice the length and twice the diameter of wire Y. What is the ratio $\frac{R_x}{R_y}$ of their resistances?

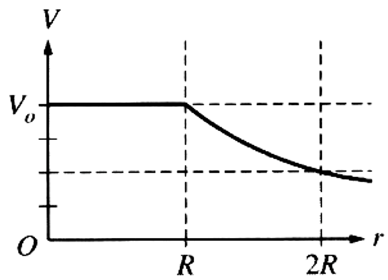
(A) $\frac{1}{4}$

(B) $\frac{1}{2}$

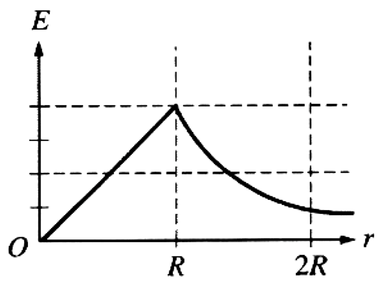
(C) 1

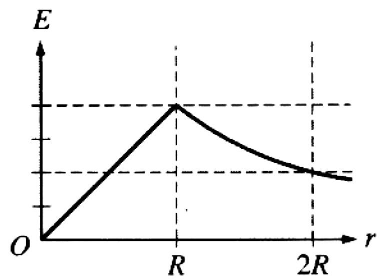
(D) 2

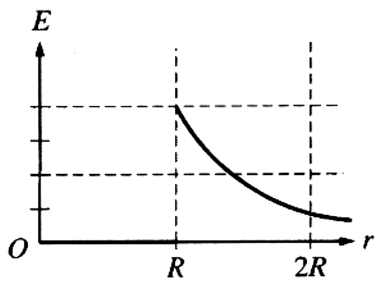
(E) 4

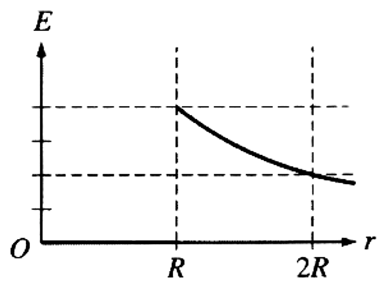


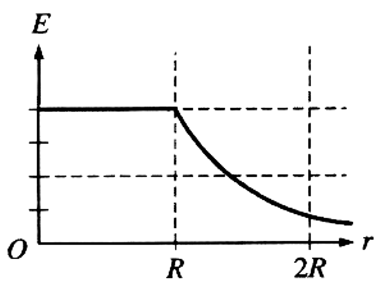
49. A solid metallic sphere of radius R has charge Q uniformly distributed on its outer surface. A graph of electric potential V as a function of position r is shown above. Which of the following graphs best represents the magnitude of the electric field E as a function of position r for this sphere?

(A)


(B)


(C)


(D)


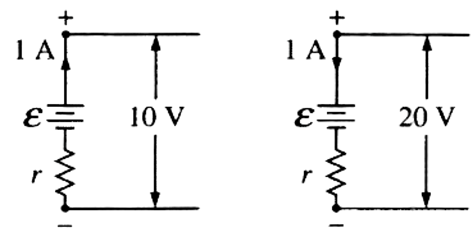
(E)


50. Two parallel wires, each carrying a current I, repel each other with a force F. If both currents are doubled, the force of repulsion is

(A) $2F$
(B) $2\sqrt{2}F$
(C) $4F$
(D) $4\sqrt{2}F$
(E) $8F$

51. A circular current-carrying loop lies so that the plane of the loop is perpendicular to a constant magnetic field of strength B. Suppose that the radius R of the loop could be made to increase with time t so that $R = at$, where a is a constant. What is the magnitude of the emf that would be generated around the loop as a function of t ?

(A) $2\pi Ba^2t$
(B) $2\pi Bat$
(C) $2\pi Bt$
(D) πBa^2t
(E) $\frac{\pi}{3}Ba^2t^3$

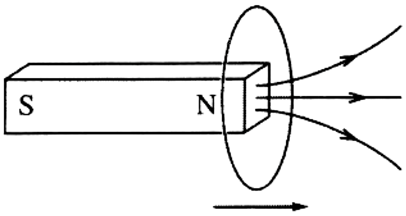


52. The figures above show parts of two circuits, each containing a battery of emf $\mathcal{E}$ and internal resistance r. The current in each battery is 1 A, but the direction of the current in one battery is opposite to that in the other. If the potential differences across the batteries' terminals are 10 V and 20 V as shown, what are the values of $\mathcal{E}$ and r ?

(A) $\mathcal{E} = 5$ V, $r = 15\ \Omega$
(B) $\mathcal{E} = 10$ V, $r = 10\ \Omega$
(C) $\mathcal{E} = 15$ V, $r = 5\ \Omega$
(D) $\mathcal{E} = 20$ V, $r = 10\ \Omega$
(E) The values cannot be computed unless the complete circuits are shown.

53. A charged particle can move with constant velocity through a region containing both an electric field and a magnetic field only if the

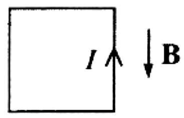
(A) electric field is parallel to the magnetic field
(B) electric field is perpendicular to the magnetic field
(C) electric field is parallel to the velocity vector
(D) magnetic field is parallel to the velocity vector
(E) magnetic field is perpendicular to the velocity vector



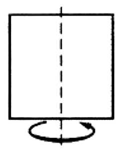
Direction Loop
is Pulled

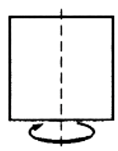
54. A conducting loop of wire that is initially around a magnet is pulled away from the magnet to the right, as indicated in the figure above, inducing a current in the loop. What is the direction of the force on the magnet and the direction of the magnetic field at the center of the loop due to the induced current?

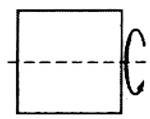
	Direction of Force on the Magnet	Direction of Magnetic Field at Center of Loop due to Induced Current
(A)	To the right	To the right
(B)	To the right	To the left
(C)	To the left	To the right
(D)	To the left	To the left
(E)	No direction; the force is zero.	To the left

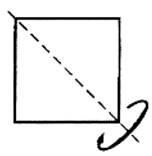


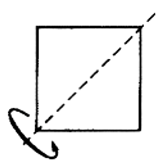
55. A square loop of wire carrying a current I is initially in the plane of the page and is located in a uniform magnetic field $\mathbf{B}$ that points toward the bottom of the page, as shown above. Which of the following shows the correct initial rotation of the loop due to the force exerted on it by the magnetic field?

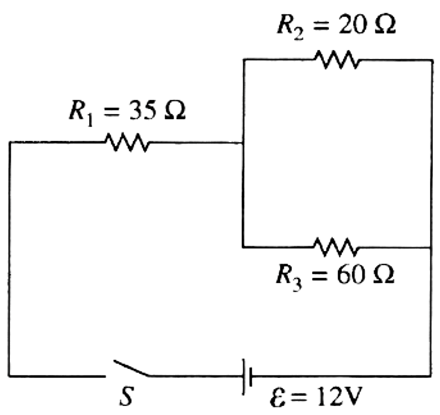
(A) 

(B) 

(C) 

(D) 

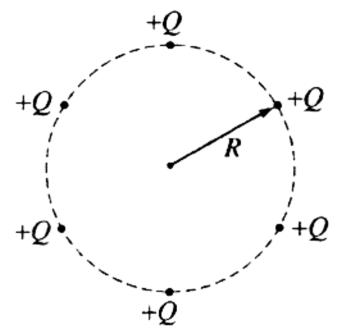
(E) 



56. In the circuit shown above, the equivalent resistance of the three resistors is

(A) 10.5 Ω
(B) 15 Ω
(C) 20 Ω
(D) 50 Ω
(E) 115 Ω

Questions 57-58



As shown in the figure above, six particles, each with charge $+Q$, are held fixed and are equally spaced around the circumference of a circle of radius R.

57. What is the magnitude of the resultant electric field at the center of the circle?

(A) 0

(B) $\dfrac{\sqrt{6}}{4\pi\epsilon_0}\dfrac{Q}{R^2}$

(C) $\dfrac{2\sqrt{3}}{4\pi\epsilon_0}\dfrac{Q}{R^2}$

(D) $\dfrac{3\sqrt{2}}{4\pi\epsilon_0}\dfrac{Q}{R^2}$

(E) $\dfrac{3}{2\pi\epsilon_0}\dfrac{Q}{R^2}$

58. With the six particles held fixed, how much work would be required to bring a seventh particle of charge $+Q$ from very far away and place it at the center of the circle?

(A) 0

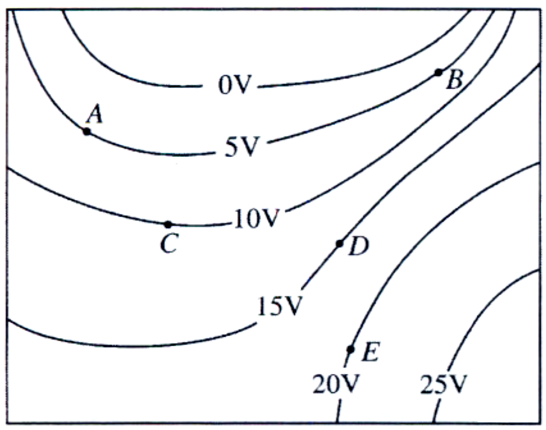
(B) $\dfrac{\sqrt{6}}{4\pi\epsilon_0}\dfrac{Q}{R}$

(C) $\dfrac{3}{2\pi\epsilon_0}\dfrac{Q^2}{R^2}$

(D) $\dfrac{3}{2\pi\epsilon_0}\dfrac{Q^2}{R}$

(E) $\dfrac{9}{\pi\epsilon_0}\dfrac{Q^2}{R}$

Questions 59-61



The diagram above shows equipotential lines produced by an unknown charge distribution. A, B, C, D, and E are points in the plane.

59. Which vector below best describes the direction of the electric field at point A ?

(A) 

(B) 

(C) 

(D) 

(E) None of the above; the field is zero.

60. At which point does the electric field have the greatest magnitude?

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

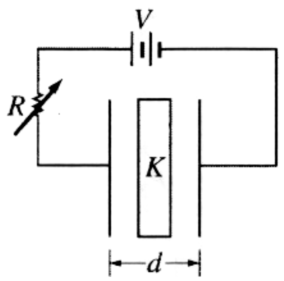
61. How much net work must be done by an external force to move a $-1\ \mu C$ point charge from rest at point C to rest at point E ?

(A) $-20\ \mu J$
(B) $-10\ \mu J$
(C) $10\ \mu J$
(D) $20\ \mu J$
(E) $30\ \mu J$

---

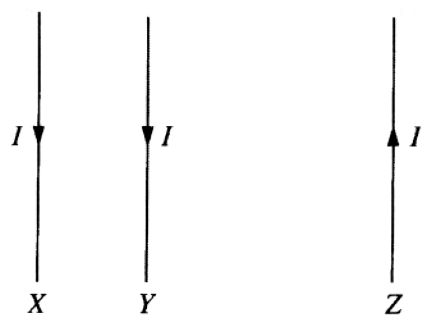
62. One of Maxwell's equations can be written as $\oint \mathbf{E} \cdot \mathbf{ds} = -\frac{d\phi_m}{dt}$. This equation expresses the fact that

(A) a changing magnetic field produces an electric field
(B) a changing electric field produces a magnetic field
(C) the net magnetic flux through a closed surface depends on the current inside
(D) the net electric flux through a closed surface depends on the charge inside
(E) electric charge is conserved



63. The plates of a parallel-plate capacitor of cross-sectional area A are separated by a distance d, as shown above. Between the plates is a dielectric material of constant K. The plates are connected in series with a variable resistance R and a power supply of potential difference V. The capacitance C of this capacitor will increase if which of the following is decreased?

(A) A
(B) R
(C) K
(D) d
(E) V



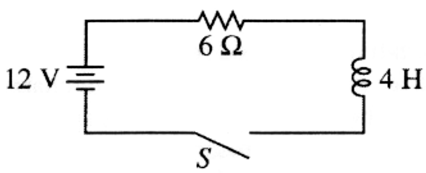
64. The currents in three parallel wires, X, Y, and Z, each have magnitude I and are in the directions shown above. Wire Y is closer to wire X than to wire Z. The magnetic force on wire Y is

(A) zero
(B) into the page
(C) out of the page
(D) toward the bottom of the page
(E) toward the left

65. A physics problem starts: "A solid sphere has charge distributed uniformly throughout . . ." It may be correctly concluded that the

(A) electric field is zero everywhere inside the sphere
(B) electric field inside the sphere is the same as the electric field outside
(C) electric potential on the surface of the sphere is not constant
(D) electric potential in the center of the sphere is zero
(E) sphere is not made of metal

Questions 66-67 relate to the circuit represented below. The switch S, after being open for a long time, is then closed.



66. What is the current in the circuit after the switch has been closed a long time?

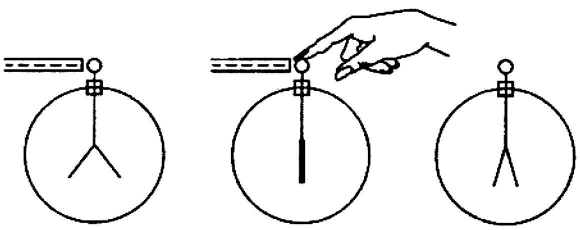
(A) 0 A
(B) 1.2 A
(C) 2 A
(D) 3 A
(E) 12 A

67. What is the potential difference across the resistor immediately after the switch is closed?

(A) 0 V
(B) 2 V
(C) 7.2 V
(D) 8 V
(E) 12 V

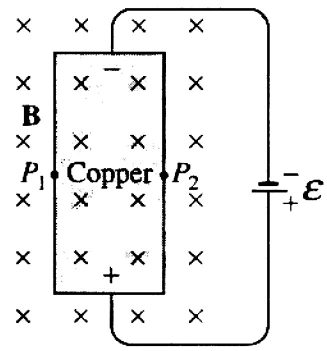
68. A uniform spherical charge distribution has radius R. Which of the following is true of the electric field strength due to this charge distribution at a distance r from the center of the charge?

(A) It is greatest when $r = 0$.
(B) It is greatest when $r = R/2$.
(C) It is directly proportional to r when $r > R$.
(D) It is directly proportional to r when $r < R$.
(E) It is directly proportional to r^2.



69. When a negatively charged rod is brought near, but does not touch, the initially uncharged electroscope shown above, the leaves spring apart (I). When the electroscope is then touched with a finger, the leaves collapse (II). When next the finger and finally the rod are removed, the leaves spring apart a second time (III). The charge on the leaves is

(A) positive in both I and III
(B) negative in both I and III
(C) positive in I, negative in III
(D) negative in I, positive in III
(E) impossible to determine in either I or III



70. A sheet of copper in the plane of the page is connected to a battery as shown above, causing electrons to drift through the copper toward the bottom of the page. The copper sheet is in a magnetic field **B** directed into the page. P_1 and P_2 are points at the edges of the strip. Which of the following statements is true?

(A) P_1 is at a higher potential than P_2.
(B) P_2 is at a higher potential than P_1.
(C) P_1 and P_2 are at equal positive potential.
(D) P_1 and P_2 are at equal negative potential.
(E) Current will cease to flow in the copper sheet.

END OF SECTION I, ELECTRICITY AND MAGNETISM