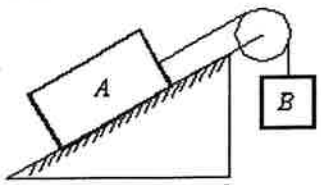
本科目不可以使用計算機　　本科目試題共 8 頁

選擇題 (單選題，共 50 題，一題 2 分，答錯不扣分)：

1. An object starts from rest at the origin and moves along the x axis with a constant acceleration of 4 m/s^2. Its average velocity as it goes from $x = 2$ m to $x = 8$ m is:
   (A) 1 m/s (B) 2 m/s (C) 3 m/s (D) 5 m/s (E) 6 m/s
2. A ball is thrown horizontally from the top of a 20-m high hill. It strikes the ground at an angle of 45°. With what speed was it thrown? Use $g = 10$ m/s^2.

   (A) 14 m/s (B) 20 m/s (C) 28 m/s (D) 32 m/s (E) 40 m/s
3. The speed of a particle moving in a circle 2.0 m in radius increases at the constant rate of 6.0 m/s^2. At an instant when the magnitude of the total acceleration is 10.0 m/s^2, what is the speed of the particle?
   (A) 3.0 m/s (B) 4.0 m/s (C) 5.0 m/s (D) 6.0 m/s (E) 8.0 m/s
4. Block A, with a mass of 10 kg, rests on a 30° incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 8.0 kg, is attached to the dangling end of the string (take $\sqrt{3} \approx 1.7$ and $g = 10\ m/s^2$). The acceleration of B is:



   (A) 0.72 m/s^2, up (B) 0.72 m/s^2, down (C) 2.6 m/s^2, up (D) 2.6 m/s^2, down (E) 0 m/s^2
5. Block A, with mass m_A, is initially at rest on a horizontal floor. Block B, with mass m_B, is initially at rest on the horizontal top surface of A. The coefficient of static friction between the two blocks is μ_s. Block A is pulled with a horizontal force It begins to slide out from under B if the force is greater than:
   (A) $m_A g$ (B) $m_B g$ (C) $\mu_s m_A g$ (D) $\mu_s m_B g$ (E) $\mu_s (m_A + m_B) g$
6. As a 2.0-kg object moves from $\left(2\hat{\mathbf{i}} + 5\hat{\mathbf{j}}\right)$ m to $\left(6\hat{\mathbf{i}} - 2\hat{\mathbf{j}}\right)$ m, the constant resultant force acting on it is equal to $\left(4\hat{\mathbf{i}} - 3\hat{\mathbf{j}}\right)$ N. If the speed of the object at the initial position is 4.0 m/s, what is its kinetic energy at its final position?
   (A)62 J (B) 53 J (C) 73 J (D) 86 J (E) 24 J
7. A certain pendulum consists of a 1.5-kg mass swinging at the end of a string (length = 2.0 m). At the lowest point in the swing the tension in the string is equal to 20 N. To what maximum height above this lowest point will the mass rise during its oscillation? Take g = 10 m/s^2
   (A)77 cm (B) 50 cm (C) 63 cm (D) 33 cm (E) 95 cm
8. A 10-g bullet moving horizontally with a speed of 2.0 km/s strikes and passes through a 4.0-kg block moving with a speed of 4.0 m/s in the opposite direction on a horizontal frictionless surface. If the block is brought to rest by the collision, what is the kinetic energy of the bullet as it emerges from the block?
   (A)0.51 kJ (B) 0.29 kJ (C) 0.80 kJ (D) 0.13 kJ (E) 20.0 kJ

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9. A wheel of radius R is mounted on a frictionless, horizontal axle that is perpendicular to the wheel and passes through the center of mass of the wheel. A light cord wrapped around the wheel supports a object of mass m. If released from rest with the string taut, the object is observed to fall with a downward acceleration of 4.0 m/s^2. If the moment of inertia (of the wheel) about the given axle is written as βmR^2, then β=? Take g = 10 m/s^2.
(A)1.0 (B) 1.5 (C) 2.0 (D) 3.0 (E) 3.5

10. A merry-go-round of radius R = 2.0 m has a moment of inertia I = 250 kg·m^2, and is rotating at 10 rpm. A child whose mass is 25 kg jumps onto the edge of the merry-go-round, heading directly toward the center at 6.0 m/s. The new angular speed (in rpm) of the merry-go-round is approximately
(A)10 (B) 9.2 (C) 8.5 (D) 7.1 (E) 6.4

11. The figure shows a uniform rod (length L = 1.0 m, mass m = 2.0 kg) suspended from a pivot a distance d = 0.25 m above its center of mass. If the angular frequency for small oscillations is ω, then ω^2, in (rad/s)^2, is approximately (Given the moment of inertia about a perpendicular axis through the center of mass is $I_{CM} = mL^2/12$ and take g = 10 m/s^2)
(A)1.0 (B) 6.25 (C) 2.25 (D) 17.1 (E) 12.25

12. A ball of mass m_B is released from rest and acquires velocity of magnitude v_B before hitting the ground. The ratio of the kinetic energy the Earth (mass m_E) acquires to the kinetic energy the ball acquires is
(A) 0. (B) $\left(\frac{m_B}{m_E}\right)^2$. (C) $\frac{m_B}{m_E}$. (D) 1. (E) $\frac{m_E}{m_B}$.

13. An asteroid revolves around the Sun with a perihelion 0.5 AU and an aphelion of 7.5 AU. What is its period of revolution? Knowing that 1AU is the average radius of the Earth orbit around the Sun
(A)4 years (B) 8 years (C) 16 years (D) 32 years (E) 64 years

14. A 3.0-kg block is on a horizontal surface. The block is at rest when, at t = 0, a force (magnitude P = 12 N) acting parallel to the surface is applied to the block causing it to accelerate. The coefficient of kinetic friction between the block and the surface is 0.20. At what rate is the force P doing work on the block at t = 2.0 s? Take g = 10 m/s^2.
(A)54 W (B) 48 W (C) 42 W (D) 59 W (E) 24 W

15. Star X is 200 light-years away from the Earth. Astronauts Joe and Mary, both at age of 30, travel together to star X in a spaceship that moves with constant speed of $\sqrt{0.9999}c$. When they reach star X, what is the age of Joe observed by Mary?
(A) Joe and Mary are already dead since it takes about 200 years to get there.
(B) Joe is still about 30 years old since it takes less than 3 months to get there.
(C) Joe is about 32 years old.
(D) Joe is about 35 years old
(E) Joe is 50 years old.

16. A bubble having a volume of 1.00 cm^3 is released from the bottom of a water tank where the depth is 10.0 m. What will the volume of the bubble be when it reaches the surface? The temperature of the water at the surface is 27.0 °C, whereas it is 57.0°C at the bottom. (The density of water is 1.00 × 10^3 kg/m^3. Take g = 10 m/s^2 and 1 atm = 1.0 × 10^5 Pa)
(A)1.10 cm^3 (B) 2.20 cm^3 (C) 1.45 cm^3 (D) 1.65 cm^3 (E) 1.35 cm^3

17. Liquid metal of mass m kg at 500 K is mixed with the same liquid metal of same mass at 1500 K.

Given the specific heat of the metal is c cal/K, find the change in entropy (in cal/K) of the system. Take ln 2 = 0.70, ln 3 = 1.10, ln 4 =1.40, ln 5 = 1.61.
(A)+2.0 mc (B) +0.6 mc (C) −1.0 mc (D) +0.3 mc (E) −0.21 mc

18. A 5.23-g pebble is dropped from a 300-m building. If it reaches a terminal velocity of 40 m/s, and the rest of the energy is converted to heating the coin, what is the change in temperature (in °C) of the coin? (The specific heat of pebble is 400 J/kg·°C Take $g = 10$ m/s^2.)
(A)8.5 (B) 2.8 (C) 5.5 (D) 21 (E) 0.5

19. While temperature is kept constant, if consider only translational and rotational motion, what is the total energy of 1 liter (10^{-3} m^3) of nitrogen gas with pressure of 1 atm (take 1 atm=10^5 Pa) ?
(A) 0. 1 kJ (B) 0.15 kJ (C) 0.2 kJ (D) 0.25 kJ (E) 0.35 kJ

20. n moles of ideal gas of pressure P and volume V undergoes an irreversible expansion with final pressure is P/3 and volume 3V. With R is the universal gas constant, find the entropy exchange of the process.
(A) 0 (B) nR ln3 (C) 3 nR (D) nR ln 6 (E) 6 nR

21. An object hangs from a spring balance. The balance indicates 30 N in air and 20 N when the object is submerged in water. What mass of the object would weigh 20N by the balance when the object is submerged in a liquid with a density that is half that of water? Take $g = 10$ m/s^2.
(A) 20 N (B) 25 N (C) 30 N (D) 35 N (E) 40 N

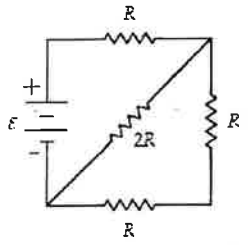
22. Water is streaming downward from a faucet opening with an area of $3.0\times10^{-5}m^2$. It leaves the faucet with a speed of 5.0 m/s. The cross-sectional area of the stream 0.55 m below the faucet is how many $10^{-5}m^2$: (Take $g = 10$ m/s^2.)
(A) 1.5 (B) 2.0 (C) 2.5 (D) 3.0 (E) 3.5

23. A police crime lab is trying to determine whether someone was murdered or died as a result of an accident. He was struck in the temple by a 4.00 kg sculpture that is alleged to have fallen off a bookcase. The sculpture presumably fell a distance of 1.80 m and the corner that struck him had an area of 0.240 cm^2. If the time for the sculpture to stop was 1.00 ms, take $g = 10.0$ m/s^2, the pressure on his temple, in N/m^2, was
(A)1.00×10^4. (B) 1.50×10^5. (C) 1.50×10^6 (D) 1.00×10^9. (E) 1.25×10^9

24. A venturi tube may be used as the inlet to an automobile carburetor. If the 2.0-cm diameter horizontal pipe narrows to a 1.0-cm diameter, what is the pressure drop in the constricted section for an airflow of 2.0 m/s in the 2.0-cm section? ($\rho = 1.2$ kg/m^3.)
(A)70 Pa (B) 85 Pa (C) 95 Pa (D) 20 Pa (E) 36 Pa

25. Determine the minimum area of a flat ice floe 1.0 meter thick if it is to support a 2 000-kg car above seawater. ($\rho_{ice} = 920$ kg/m^3, $\rho_{sea} = 1\,020$ kg/m^3.)
(A) 20 m^2 (B) 40 m^2 (C) 60 m^2 (D) 80 m^2 (E) 100 m^2

26. At what rate is thermal energy being generated in the $2R$-resistor when $\varepsilon = 12$ V and $R = 3.0\ \Omega$?

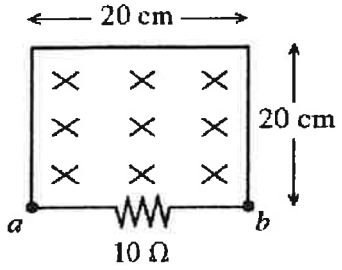


(A)12 W (B) 24 W (C) 6.0 W (D)3.0 W (E)1.5 W

27. A charged capacitor stores energy U. Without connecting this capacitor to anything, dielectric

having dielectric constant K is now inserted between the plates of the capacitor, completely filling the space between them. How much energy does the capacitor now store?
(A)$2KU$ (B)KU (C)U (D)U/K (E)$U/(2K)$

28. As shown in the figure, a wire and a 10-Ω resistor are used to form a circuit in the shape of a square, 20 cm by 20 cm. A uniform but nonsteady magnetic field is directed into the plane of the circuit. The magnitude of the magnetic field is decreased from 1.50 T to 0.50 T in a time interval of 63 ms. The average induced current and its direction through the resistor, in this time interval, are closest to



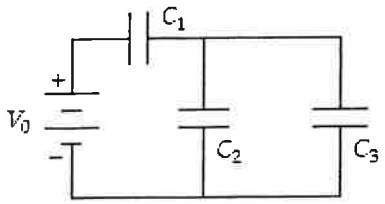
(A) 63 mA, from b to a. (B)38 mA, from b to a. (C) 63 mA, from a to b.
(D) 38 mA, from a to b. (E) 95 mA, from a to b.

29. A transverse wave traveling along a string transports energy at a rate r. If we want to double this rate, we could
(A) increase the amplitude of the wave by a factor of 8.
(B) increase the amplitude of the wave by a factor of 4.
(C) increase the amplitude of the wave by a factor of 2.
(D) increase the amplitude by a factor of $\sqrt{2}$.
(E) increase the amplitude by a factor of $\sqrt{8}$.

30. A tube open at one end and closed at the other end produces sound having a fundamental frequency of 350 Hz. If you now open the closed end, the fundamental frequency becomes
(A) 87.5 Hz. (B) 175 Hz. (C) 350 Hz. (D) 700 Hz. (E) 1400 Hz.

31. A solid nonconducting sphere of radius R carries a charge Q distributed uniformly throughout its volume. At a certain distance $r1$ ($r1 < R$) from the center of the sphere, the electric field has magnitude E. If the same charge Q were distributed uniformly throughout a sphere of radius $2R$, the magnitude of the electric field at the same distance $r1$ from the center would be equal to
(A) $E/8$. (B) $E/2$.(C) $2E$.(D) $8E$. (E) E.

32. Determine the energy stored in C_2 when $C_1 = 15\ \mu$F, $C_2 = 10\ \mu$F, $C_3 = 20\ \mu$F, and $V_0 = 18$ V.



(A)0.72 mJ (B)0.32 mJ (C)0.50 mJ (D)0.18 mJ (E)1.60 mJ

33. A charge per unit length given by $\lambda(x) = bx$, where $b = 12$ nC/m^2, is distributed along the x axis from $x = +9.0$ cm to $x = +16$ cm. If the electric potential at infinity is taken to be zero, what is the electric potential at the point P on the y axis at $y = 12$ cm?
(A)5.4 V (B)7.2 V (C)9.0 V (D)9.9 V (E)16 V

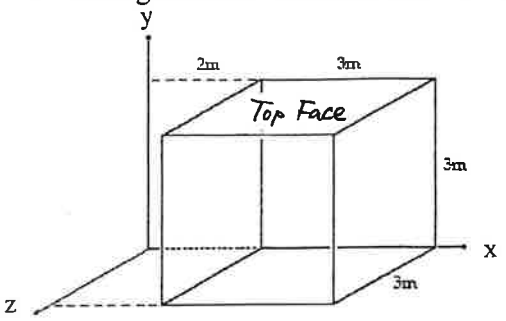
34. A 16-nC charge is distributed uniformly along the x axis from $x = 0$ to $x = 4$ m. Which of the

following integrals is correct for the magnitude (in N/C) of the electric field at $x = +10$ m on the x axis?

(A) $\int_0^4 \frac{36dx}{(10-x)^2}$ (B) $\int_0^4 \frac{154dx}{(10-x)^2}$ (C) $\int_0^4 \frac{36dx}{x^2}$ (D) $\int_6^{10} \frac{154dx}{x^2}$

(E) none of these

35. The electric field in the region of space shown is given by $\vec{E} = (8\hat{i} + 2\hat{j})$ N/C where y is in m. What is the magnitude of the electric flux through the top face of the cube shown?



(A) 90 N · m²/C (B) 6.0 N · m²/C (C)54 N · m²/C (D)12 N · m²/C (E) 126N · m²/C

36. A charge per unit length given by $\lambda(x) = bx$, where $b = 12$ nC/m², is distributed along the x axis from $x = +9.0$ cm to $x = +16$ cm. If the electric potential at infinity is taken to be zero, what is the electric potential at the point P on the y axis at $y = 12$ cm?
(A)5.4 V (B)7.2 V (C)9.0 V (D)9.9 V (E)16 V

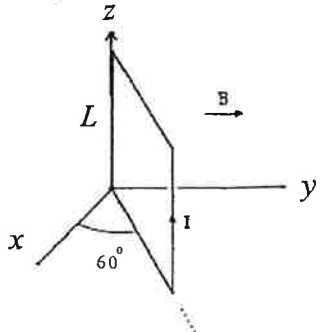
37. When a cube is inscribed in a sphere of radius r, the length L of a side of the cube is $L = \sqrt{\frac{4}{3}}\, r$. If a positive point charge Q is placed at the center of the spherical surface, the ratio of the electric flux Φ_{sphere} at the spherical surface to the flux Φ_{cube} at the surface of the cube is

(A) $\frac{4}{3}$ (B) $\sqrt{\frac{4}{3}}$ (C)1 (D) $\sqrt{\frac{3}{4}}$ (E) $\frac{3}{4}$

38. For the potential $V = 3x^2z - 2yz^3$, what is the corresponding electric field at the point (2,2,2)?

(A) $-24\hat{i} + 16\hat{j} + 36\hat{k}$ (B) $12\hat{i} - 16\hat{j} - 16\hat{k}$ (C) $24\hat{i} - 16\hat{j} - 36\hat{k}$ (D) $-6\hat{i} + 2\hat{j} + 6\hat{k}$
(E)The correct answer is not given.

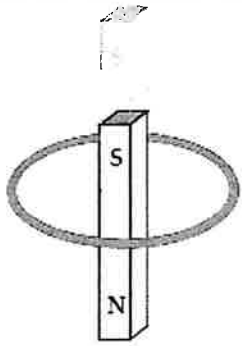
39. A square loop ($L = 0.20$ m) consists of 50 closely wrapped turns, each carrying a current of 0.50 A. The loop is oriented as shown in a uniform magnetic field of 0.40 T directed in the positive y



direction. What is the magnitude of the torque on the loop?

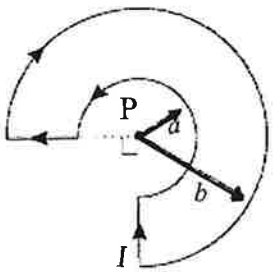
(A) 0.21 N · m (B) 0.20 N · m (C) 0.35 N · m (D) 0.12 N · m (E) 1.73 N · m

40. A bar magnet is dropped from above and falls through the loop of wire shown below. The north pole of the bar magnet points downward towards the page as it falls. Which statement is correct?



(A) The current in the loop always flows in a clockwise direction.
(B) The current in the loop always flows in a counterclockwise direction.
(C) The current in the loop flows first in a clockwise, then in a counterclockwise. direction.
(D) The current in the loop flows first in a counterclockwise, then in a clockwise. direction.
(E) No current flows in the loop because both ends of the magnet move through the. loop

41. What is the magnitude of the magnetic field at point P if $a = R$ and $b = 2R$?

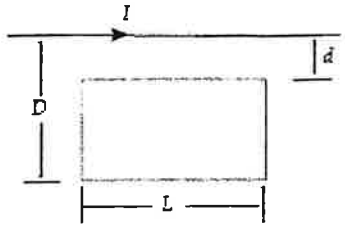


(A) $\frac{9\mu_0 I}{16R}$ (B) $\frac{3\mu_0 I}{16R}$ (C) $\frac{\mu_0 I}{4R}$ (D) $\frac{3\mu_0 I}{4R}$ (E) $\frac{3\mu_0 I}{8R}$

42. A long wire carries a current of 3.0 A along the axis of a long solenoid (radius = 3.0 cm, n = 900 turns/m, current = 30 mA). What is the magnitude of the magnetic field at a point 2.0 cm from the axis of the solenoid? Neglect any end effects.
(A)34 μT (B)64 μT (C)30 μT (D)45 μT (E)4.0 μT

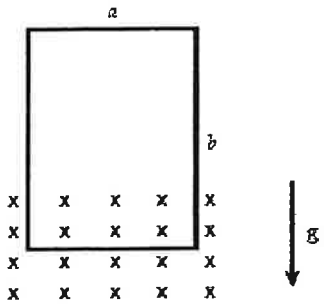
43. A uniform magnetic field is applied perpendicular to the plane of a 60-turn circular coil with a radius of 6.0 cm and a resistance of 0.60 Ω. If the magnetic field increases uniformly from 0.20 T to 1.8 T in 0.20 s, what is the magnitude of the emf induced in the coil?
(A)7.2 V (B)5.4 V (C)9.2 V (D)12 V (E)16 V

44. A loop of wire (resistance = 2.0 mΩ) is positioned as shown with respect to a long wire which carries a current. If d = 1.0 cm, D = 6.0 cm, and L = 1.5 m, what current (I) is induced in the loop



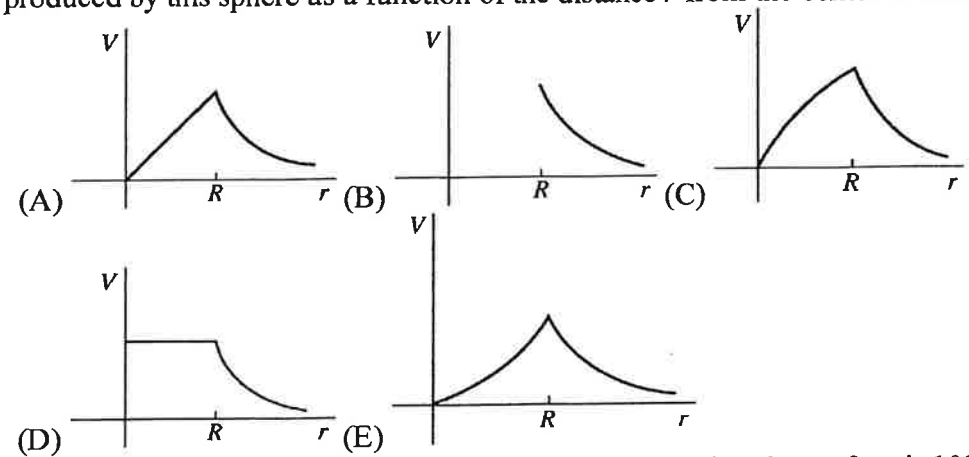
at an instant when the current in the wire is increasing at a rate of 100 A/s?
(A)34 mA(B)30 mA(C)27 mA(D)38 mA(E)0.50 mA

45. A conducting rectangular loop of mass M, resistance R, and dimensions $a \times b$ is allowed to fall from rest through a uniform magnetic field which is perpendicular to the plane of the loop. The loop accelerates until it reaches a terminal speed (before the upper end enters the magnetic field). If a = 2.0 m, B = 6.0 T, R = 40 Ω, and M = 0.60 kg, what is the terminal speed?



(A) 1.6 m/s (B) 20 m/s (C) 2.2 m/s (D) 26 m/s (E) 5.3 m/s

46. A conducting sphere of radius R carries an excess positive charge and is very far from any other charges. Which one of the following graphs best illustrates the potential (relative to infinity) produced by this sphere as a function of the distance r from the center of the sphere?



47. A conducting sphere is charged up such that the potential on its surface is 100 V (relative to infinity). If the sphere's radius were twice as large, but the charge on the sphere were the same, what would be the potential on the surface relative to infinity?
(A) 50 V (B) 25 V (C) 100 V (D) 200 V (E) 150 V

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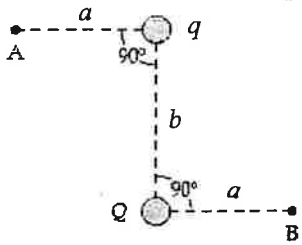
48. Point charges q and Q are positioned as shown. If $q = +2.0$ nC, $Q = -2.0$ nC, $a = 3.0$ m, and $b = 4.0$ m, what is the electric potential difference, $V_A - V_B$?



(A)8.4 V (B)6.0 V (C)7.2 V (D)4.8 V (E) 0 V

49. Addition of a metal slab of thickness a between the plates of a parallel plate capacitor of plate separation d is equivalent to introducing a dielectric with dielectric constant κ between the plates. The value of κ is
(A)*(d-a)/d* (B)d (C)$d - a$ (D)*d/(d-a)* (E)*d/a*.

50. The magnitude of the magnetic field at point P for a certain electromagnetic wave is 2.12 μT. What is the magnitude of the electric field for that wave at P ? ($c = 3.0 \times 10^8$ m/s)
(A)636 N/C (B)745 N/C (C) 5.23 μN/C (D) 6.36 μN/C (E)7.45 μN/C