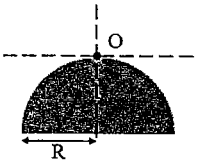
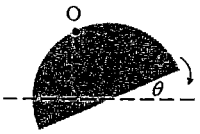
單選題，答案請填於答案卡。一題5分，答錯倒扣1分，整題不作答不給分也不扣分。
（倒扣至該大題0分為止）

1. What physical quantity is in common when a person throws a ball upward or horizontally with the same initial speed 5 m/s? (A) The positive work done by the gravity (B) The final speed before hitting the ground (C) The amount of time spent before hitting the ground (D) The vertical component of the final linear momentum before hitting the ground (E) The distance it travels before hitting the ground.

2. A semi disk of radius R is shown in the right figure. The origin O (0, 0) is located at the top of the disk. Where is the center of mass of the semi disk? (A) (0, -0.28R) (B) (0, -0.38R) (C) (0, -0.48R) (D) (0, -0.51R) (E) (0, -0.58R)

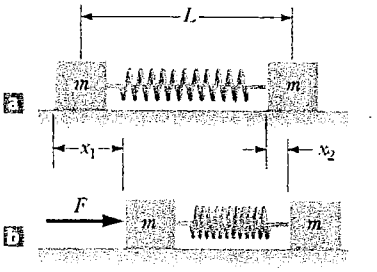


3. If the semi disk is fixed at point O and starts to rotate with small angle θ under gravity, what is the period of the simple harmonic motion (SHM)? (A) $\pi\sqrt{2.3\frac{R}{g}}$ (B) $\pi\sqrt{4.5\frac{R}{g}}$ (C) $\pi\sqrt{5.5\frac{R}{g}}$ (D) $\pi\sqrt{6.3\frac{R}{g}}$ (E) $\pi\sqrt{7.2\frac{R}{g}}$



4. The potential energy of a point mass 1 kg at a distance 0.6 m from the center of a solid sphere with the radius 1 m and the mass 2 kg is (A) −2.24G J (B) −1.64G J (C) −0.8G J (D) −2.64G J (E) −1.12G J (G is the gravitational constant)

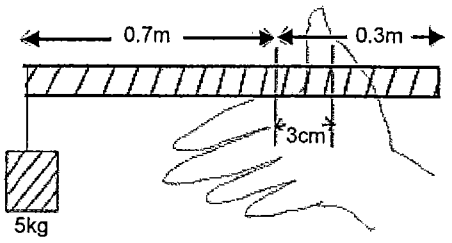
5. As shown in the top figure, two blocks are at rest on a frictionless, level table. Both blocks have the same mass m, and they are connected by a spring of negligible mass. The separation distance of the blocks when the spring is relaxed is L. During a time interval Δt, a constant force of magnitude F is applied horizontally to the left block, moving it through a distance x_1 as shown in the bottom figure. During this time interval, the right block moves through a distance x_2. At the end of this time interval when the force F is removed, what is the total energy of the system associated with vibration relative to its center of mass? (which includes the vibrational energy of the two blocks relative to C.M. and the potential energy of the spring.)



(A) $\frac{F(x_1+x_2)}{2}$ (B) $\frac{F(x_1-x_2)}{4}$ (C) $\frac{F(x_1-x_2)}{2}$ (D) $\frac{F^2(x_1+x_2)}{2}$ (E) It cannot be determined.

6. A comet moves in an elongated elliptical orbit around the sun. At perihelion (近日點), the comet is 8.75×10^7 km from the Sun with the speed 5.5×10^4 m/sec. At aphelion (遠日點), it is 5.26×10^9 km from the sun. The period of the orbit is (A) 64 years (B) 68 years (C) 78 years (D) 75 years (E) 52 years

7. A martial-art monk wants to practice his palm power. As seen from the figure, he wants to raise this weight of 5 kg hang at one end of the uniform rod of length L (1 m) and mass 0.5 kg. The position he applies his force using the thumb (拇指) and index finger (食指) is shown. The minimum force he needs to exert to raise this weight is (A) 100.5 kgw (B) 110.5 kgw (C) 120. 5 kgw (D) 125.5 kgw (E) 128.3 kgw (Forces exerted by the thumb and the index finger could be different. Take the larger one for your answer.)



8. A continuous triangular wave on a taut string travels in the positive x-direction with speed v. The tension in the string is F, and the linear mass density of the string is μ. At t = 0, the shape of the pulse is given by

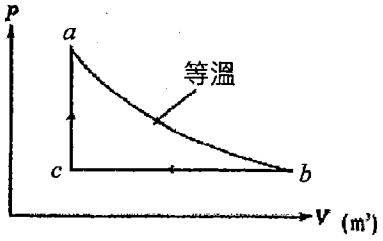
$y(x, 0) = h\dfrac{L-(x-2nL)}{L}$ for $2nL < x < (2n+1)L$, and

$y(x, 0) = h\dfrac{L+(x-2(n+1)L)}{L}$ for $(2n+1)L<x<(2n+2)L$, where $n = 0, \pm1, \pm2, \pm3\ldots$

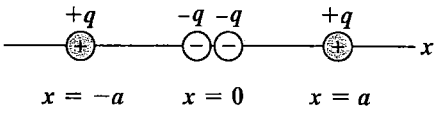
The power of the wave is (A) $P_{av} = \dfrac{Fvh^2}{2L^2}$ (B) $P_{av} = \dfrac{Fvh^2}{L^2}$ (C) $P_{av} = \dfrac{2Fvh^2}{L^2}$ (D) $P_{av} = \dfrac{4Fvh^2}{L^2}$ (E) 0

9. 2 moles of helium gas are heated from 0 °C to 100 °C at constant pressure. The work done by the gas to the environment is (A) 2770 J (B) 4155 J (C) 1335 J (D) 2493 J (E) 1662 J (ideal gas constant = 8.31 $J\cdot K^{-1}\cdot mol^{-1}$)

10. Five moles of an ideal diatomic gas ($\gamma = 1.4$) operate in the cycle shown in the right figure, where Ta = 400 K, Tc = 200 K and Pc = 100 kPa. Process a-b is isothermal. The efficiency of this heat engine is (A) 9.9 % (B) 15.5 % (C) 27.9 % (D) 35.7 % (E) 41.2 %



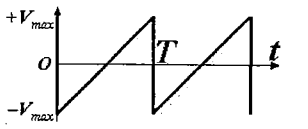
11. Two electric dipoles are placed at opposite direction as shown in the figure. The electric field at some location x ($x >> a$) will decrease as (A) $\frac{1}{x}$ (B) $\frac{1}{x^2}$ (C) $\frac{1}{x^3}$ (D) $\frac{1}{x^4}$ (E) $\frac{1}{x^{3/2}}$



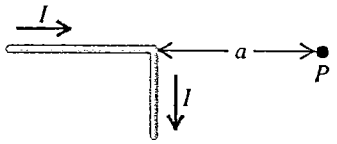
12. Which of the following statements is correct? (A) The surface charge density (charge per unit area) of a conductor must be uniform. (B) The electric field line is the trajectory of a charged particle under electric field. (C) The conductor can be thought of as a dielectric material with dielectric constant $K = 0$. (D) If the electric potential at some position is zero, the electric field at that position must also be zero. (E) The surface of a conductor is an equipotential surface. (The conductor mentioned above is perfect and has zero resistance.)

13. Two solid spherical metal balls A and B with radius a and b are initially far apart. Ball A initially has charge Q and ball B is neutral. Now, they are connected by a conducting wire. How much charge will flow from ball A to ball B? (A) $\frac{b}{a}Q$ (B) $\frac{a}{b}Q$ (C) $\frac{b}{a+b}Q$ (D) $\frac{a}{a+b}Q$ (E) $\frac{b^2}{a^2+b^2}Q$

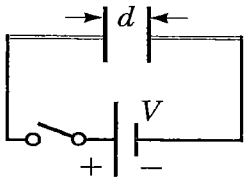
14. What is the root-mean-square value of the voltage shown in the figure? The function is a triangular wave with its peak voltage at $\pm V_{max}$ and a period of T. (A) $\frac{V_{max}}{3}$ (B) $\frac{V_{max}}{2}$ (C) $\frac{V_{max}}{\sqrt{2}}$ (D) $\frac{V_{max}}{2\sqrt{2}}$ (E) $\frac{V_{max}}{\sqrt{3}}$



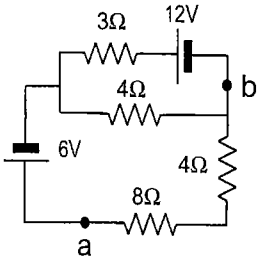
15. The wires shown in right figure are infinitely long and carry currents I. Find the magnetic fields at point P, which is at a distance a from the turning point. (A) $\frac{\mu_0 I}{4\pi a}$ (B) $\frac{\mu_0 I}{2\pi a}$ (C) $\frac{\mu_0 I}{2a}$ (D) $\frac{\mu_0 I}{4a}$ (E) $\frac{\mu_0 I}{a}$



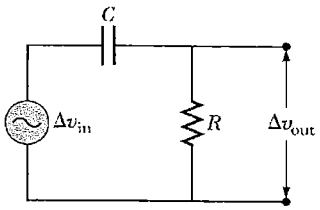
16. Two identical parallel metal plates separated by a distance d form a capacitor of capacitance C. It is now connected to a battery of voltage V. What is the force between the two plates when it is fully charged? The sides of the plate is much larger than d. (A) $\frac{CV^2}{8d}$ (B) $\frac{CV^2}{2d}$ (C) $\frac{CV^2}{4d}$ (D) $\frac{CV^2}{d}$ (E) $\frac{CV^2}{3d}$



17. For the circuit shown in the right figure, what is the potential difference between points **a** and **b**? (hint: you can add only one battery each time, and combine the two results together.) (A) 10.25 V (B) 10. 85 V (C) 11.25 V (D) 6.75 V (E) 5.25 V



18. The RC high-pass filter shown in the right figure has a resistor R = 1 Ω and a capacitor C = 500 μF. What is the ratio of the amplitude of the output voltage to that of the input voltage for a source at angular frequency ω = 4 kHz? (A) 0.89 (B) 0.67 (C) 0.80 (D) 0.45 (E) 0.95



19. A fiber has index of refraction n = 1.15, and its end surface is normal to the direction of its length. Light is incident from the air. What is the maximum incident angle so that the light can have total internal reflection inside the fiber and propagate without loss? (A) $\sin^{-1}(0.57) \approx 35°$ (B) $\sin^{-1}(0.66) \approx 42°$ (C) $\sin^{-1}(0.75) \approx 49°$ (D) $\sin^{-1}(0.80) \approx 53°$ (E) $\sin^{-1}(0.91) \approx 65°$

20. A zoom lens consist of two identical thin convex lenses. When the two lenses are very close to each other, an incident parallel beam is focused to a position 5 cm after the 2nd lens. Now if the first lens is moved 5 cm to the front of the 2nd lens, what is the distance of the focus point to the 2nd lens? (A) 2 cm (B) 2.5 cm (C) 3.3 cm (D) 4.5 cm (E) 7.5 cm