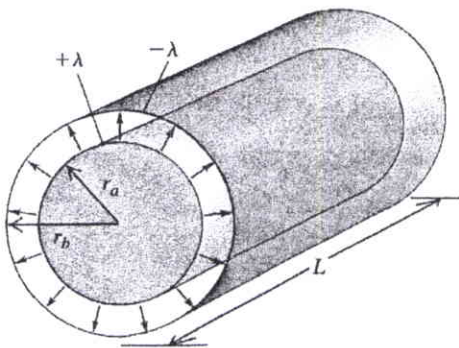


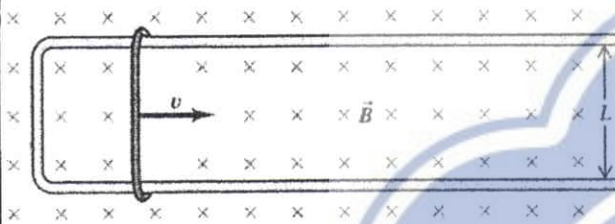
考試科目	普通物理	系所別	應用物理研究所	考試時間	2 月 4 日(四) 第 3 節
------	------	-----	---------	------	------------------

- A uniform rectangular wooden board of mass M is pivoted horizontally along its top edge without friction. The vertical edge of the board has length L . (a) Show that the moment of inertia of the board is $ML^2/3$. A bullet of mass m and horizontal velocity v strikes the board at the center and is embedded in the board. (b) Calculate the angular velocity of the board right after the impact and express it in terms of m , M , v and L . (c) If $M = 0.900$ kg, $m = 0.0100$ kg, and $L = 0.500$ m, what is the minimum v needed to swing the board over? (15%) ($g = 9.80$ m/s²)
- The potential energy of a diatomic molecule is $U(r) = \frac{A}{2b}[e^{-2b(r-R_0)} - 1] - \frac{A}{b}e^{-b(r-R_0)}$, where both A and b are positive constants and r is the distance between the two atoms. (a) Find the radial force $F(r)$ on each atom. (b) What is the minimum potential energy? What is the meaning of R_0 ? (c) If x is the difference between r and R_0 and x is much smaller than R_0 , use Taylor's expansion to show that F is proportional to x and derive the force constant k in terms of A and b . (d) If each atom of the molecule has the identical mass m , what is the vibration frequency of the molecule? What is the zero-point energy of the molecule? (20%)
- A heat engine operates between two reservoirs at $T_2 = 500$ K and $T_1 = 300$ K. It takes in 1000 J of energy from the higher-temperature reservoir and performs 250 J of work in one cycle. Find (a) the entropy change of the Universe ΔS_U for this process and (b) the work W that could have been done by an ideal Carnot engine operating between these two reservoirs. (c) Show that the difference between the amounts of work done in parts (a) and (b) is $T_1 \Delta S_U$. (15%)
- The inner conducting cylinder of a long, cylindrical capacitor has radius r_a and linear charge density λ . It is surrounded by a coaxial cylindrical conducting shell with inner radius r_b and linear charge density $-\lambda$. (a) What is the capacitance of the system per unit length? (b) What is the total electric-field energy per unit length. (10%)



考試科目	普通物理	系所別	應用物理研究所	考試時間	2 月 4 日(四) 第 3 節
------	------	-----	---------	------	------------------

5. A rectangular loop with width L and a slide wire of mass m are as shown in the figure. A uniform magnetic field \vec{B} is directed perpendicular to the plane of the loop into the plane of the figure. The slide wire is given an initial speed of v_0 at $t = 0$ and then released. There is no friction between the slide wire and the loop, and the resistance of the loop is negligible in comparison to the resistance R of the slide wire. (a) Obtain an expression for F , the magnitude of the force exerted on the slide wire while it is moving at speed v . (b) Find the speed $v(t)$ and displacement $x(t)$ in terms of B , L , m , R and v_0 . (c) Find the maximum distance the slide wire moves. (d) What is the total energy consumed by the resistance R ? (20%)



6. A source of sinusoidal electromagnetic waves radiates uniformly in all directions with an average power of 50.0 kW and frequency 100 MHz. At a distance 10.0 km from the source there is a circular loop of wire with diameter 0.200 m. Calculate (a) the intensity of the electromagnetic wave and (b) the amplitudes of the electric and magnetic fields at the location of the loop. (c) If the loop is perpendicular to the direction of the radiation's magnetic field, what is the maximum electromotive force induced in the wire? (20%)
($c = 3.00 \times 10^8$ m/s, $\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $\epsilon_0 = 8.85 \times 10^{-12}$ C²/N·m².)

備

註

- 一、作答於試題上者，不予計分。
- 二、試題請隨卷繳交。