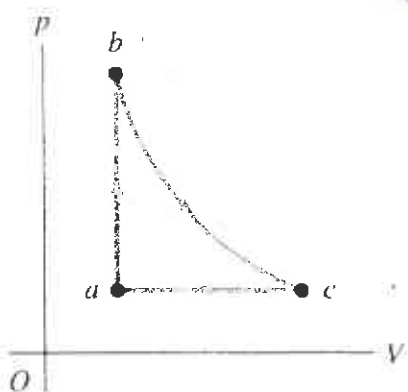


考試科目	普通物理學	所別	應用物理研究所	考試時間	2月26日(六)第三節
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1. A uniform rectangular wooden board of mass  $M$  is pivoted horizontally along its top edge. The vertical edge of the board has length  $L$ . (a) Calculate the moment of inertia of the board. A bullet of mass  $M/4$  and horizontal velocity  $v$  strikes the board at the position  $2L/3$  from the top edge and is embedded in the board. (b) Calculate the angular velocity of the board right after the impact and express it in terms of  $v$  and  $L$ . (c) What is the ratio of the kinetic energies before and right after the impact? (15%)
2. The potential energy of a KCl molecule is  $U(r) = A [(R_0^7/8r^8) - 1/r]$ , where both  $A$  and  $R_0$  are 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 the force is considered elastic, find the force constant  $k$  and express  $k$  in terms of  $A$  and  $R_0$ , using the small amplitude approximation  $r = R_0 + x$  with  $x$  being much smaller than  $R_0$ . (d) What are the vibration frequency and the vibration energy of the molecule? Assume the masses of K and Cl are  $m_1$  and  $m_2$  respectively. (20%)
3. A heat engine operates using the cycle shown in the figure. Process  $b \rightarrow c$  is adiabatic. If  $p_b/p_a = 3.00$  and  $\gamma = C_p/C_v = 1.40$ , find (a)  $V_c/V_a$  (5%) and (b) the efficiency of the engine (must be a number) (10%).



備註：試題隨卷繳交

請注意：背面還有試題。

考 試 科 目	普通物理學	所 別	應用物理研究所	考 試 時 間	2 月 26 日 ( 六 ) 第 三 節
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4. A long coaxial cable consists of an inner cylindrical conductor of radius  $a$  and an outer coaxial cylindrical conductor with inner radius  $b$  and outer radius  $c$ . The space between the two conductors is filled with nonmagnetic insulating material of dielectric constant  $K$ . Calculate (a) the capacitance per unit length and (b) the inductance per unit length. The cable is used as a lossless transmission line. (c) What is the characteristic impedance? (15%)

5. 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 20.0 km from the source there is a circular loop of wire with diameter 0.150 m. (a) Calculate the amplitudes of the electric and magnetic fields at the location of the loop. (b) 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,  $\epsilon_0 = 8.85 \times 10^{-12}$  C<sup>2</sup>/N·m<sup>2</sup>.)

6. An  $R$ - $L$ - $C$  series circuit draws an average power of 220 W from a 110-V (rms) 60.0 Hz ac line. The rms current is 2.50 A and the source voltage leads the current. (a) What is the net resistance of the circuit? (b) In order to make the whole circuit have a power factor of unity, do you connect a series capacitor or inductor to the original circuit? What value is the capacitance or inductance added? (c) What power will then be drawn from the supply line? (15%)