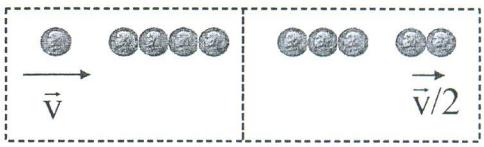
國立交通大學 100 學年度碩士班考試入學試題

科目：普通物理(4012)　　考試日期:100 年 2 月 18 日 第 2 節

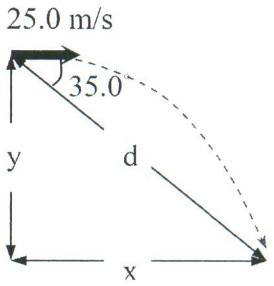
系所班別：電子物理學系　　組別：電物系甲組　　第 1 頁,共 2 頁

【不可使用計算機】＊作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符！！

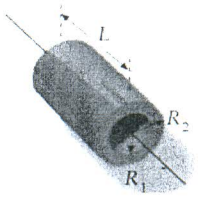
1. (a) A coin row is shown as the right figure. Is it possible for one coin to hit the four-coin row and two coins to leave from the other end with half the speed of the first coin? Why? [5%] (b) A potential energy function for a system in which a two-dimensional force acts is of the form $U = 3x^3y\text{-}7x$. Find the force that acts at the point (x, y) [5%]



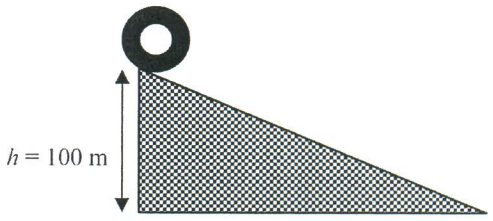
2. A ski-jumper leaves the ski track moving in the horizontal direction with a speed of 25.0 m/s, as shown in the right figure. The landing incline below him falls off with a slope of 35.0°. (a) Where does he land on the incline? [5%] (b) Suppose everything is the same except that the ski jump is curved so that the jumper is projected upward at an angle (θ) from the end of the track. If the skier would like to have the maximum length (d) of the jump, what is the value of θ he needs? [5%] ($\sin 35.0^\circ = 0.574$, $\cos 35.0^\circ = 0.819$)



3. (a) Find the moment of inertia of a uniform hollow cylinder about axis as shown in the right figure. Its mass is M. [5%] (b) There are three tires (their characteristics are as following table) on the top of an incline as shown in the following figure. These tires roll down without slipping. Find the final velocity of each tire if $R_1 << R_2$. [5%]

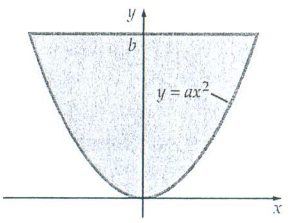


#	L(cm)	R_1(cm)	R_2(cm)	M(kg)
1	35	3	83	48
2	50	5	170	220
3	35	2	62	11

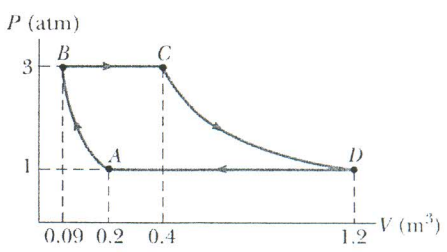


(a)

4. A sheet of metal is cut in the shape of a parabola (as shown in the right figure). The curved edge of the sheet is specified by the equation $y = ax^2$, and y ranges from 0 to b. Find the center of mass (CM) in terms of a and b. [5%] (b) The right figure is a lateral view of a top with counterclockwise spinning along y-axis from a vertical view. If the spinning axis is not along y-axis, what happen on the top? Please explain it by conservation of angular momentum. [5%] (c) If the position of CM inside the top can be varied, how to avoid the situation happened in (b)? [5%]



5. A sample of an ideal gas goes through the process as shown in the right figure. From A to B, the process is isothermal; from B to C, it is isobaric with 110 kJ of energy entering the system by heat. From C to D, the process is adiabatic; from D to A, it is isobaric with 260 kJ of energy leaving the system by heat. Determine the difference in internal energy $E_{int,B} - E_{int,A}$. [5%]



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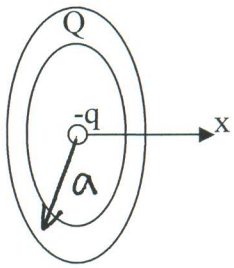
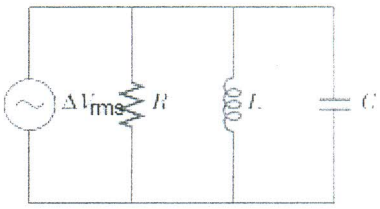
6. A negatively charged particle –q is placed at the center of a uniformly charged ring, where the ring has a total positive charge Q. The particle, confined to move along the x-axis, is moved a small distance x along the x-axis (where x << a) and released. Please show that the particle oscillates in simple harmonic motion and calculate its oscillation frequency. [10%]



7. The right figure shows a parallel RLC circuit. The instantaneous voltages (and the rms voltages) across each of the three circuit elements are the same, and each is in phase with the current in the resistor. The current in C and L lead or lag the current in the resistor. By using a phasor diagram, please obtain (a) the rms current I_{rms} delivered by the source and (b) the phase angle between ΔV_{rms} and I_{rms}. [15%]



8. (a) Please write down the Maxwell equations in vacuum. [5%] (b) Please use the Maxwell equations to derive the wave equation of the electromagnetic waves. Assume that the plane EM wave travel in x direction and its electric and magnetic fields are in y and z directions, respectively. [10%]

9. Considering that the relativistic linear momentum is $p = \dfrac{mu}{\sqrt{1-u^2/c^2}}$, where m is the mass of the particle, u is the velocity, and c is the light speed, please calculate the work $W = \int_{x1}^{x2} F dx$ done by the force $F = \dfrac{dp}{dt}$. Assume that the particle travels from x1 to x2 and its velocity increases from 0 to u. [10%]