

本試題是否可以使用計算機： 可使用， 不可使用 (請命題老師勾選)

考試日期：0302，節次：2

10%(1): Consider A cart of mass M , shown in the Fig.1, a string attaches to the cart, and hang over the pulleys on a fixed wall, then return to the cart, and passes over the pulley on the car, finally attaches to a block of mass m . neglect all the friction.

- (a) Draw free-body diagram for the cart and the block. Write down the equations of motion of the cart and the block.(6%)
- (b) The length of the string is a constant, show that $a_y = 2a_x$, where a_y is the acceleration of the block along y axis, and a_x is the acceleration of the cart.(2%)
- (c) Solve the equations of motions to find the accelerations of the block and the car, and what is the tension of the string.(2%)

10%(2): Consider a chain hangs over a table length b on one the table and length a hang on the other side. (see Fig.2)

- (a) Find the speed at instant when the chain just slide off the table.(5%)
- (b) Show that the time taken for the chain to slide off is given by the integral

$$T = \sqrt{\frac{a+b}{g}} \int_0^b \frac{1}{\sqrt{2ax+x^2}} dx \quad (5\%)$$

10%(3): Consider the object shown in Fig.3, two identical disk with radius R was connected by a axle of radius r , A string is wrapped several times around axle, and a constant force F is applied to the string, suppose the motion of the object is rolls without slipping. Show that if $\theta < \cos^{-1} \frac{r}{R}$, the object will moves forward, and if $\theta > \cos^{-1} \frac{r}{R}$, the object will moves backward.

10%(4): For ideal gas, show that

$$C_P = C_V + R$$

where C_P is the molar heat capacity at constant pressure, C_V is the molar heat capacity at constant volume, and R is gas constant.

10%(5): Fig.4 shows a Venturi tube, used to measure the speed of air flow. A air flows through the tube, the cross section area at points 1 and 2 are A_1 and A_2 , and the velocities of fluid at points 1 and 2 are v_1 and v_2 respectively, the height difference of the mercury is h . Show that the velocity of fluid at the points 1 and 2 are

$$v_1 = A_2 \sqrt{\frac{2\rho_m g h}{\rho_a (A_1^2 - A_2^2)}}, \quad v_2 = A_1 \sqrt{\frac{2\rho_m g h}{\rho_a (A_1^2 - A_2^2)}}$$

where ρ_m, ρ_a are the mass density of the mercury and the air respectively.

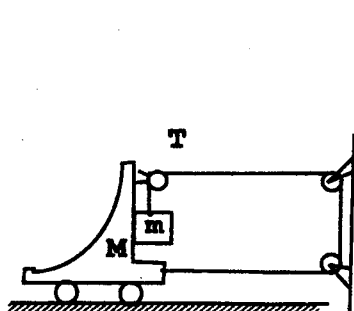


Fig-1

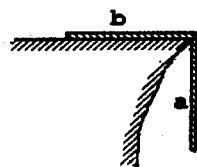


Fig-2

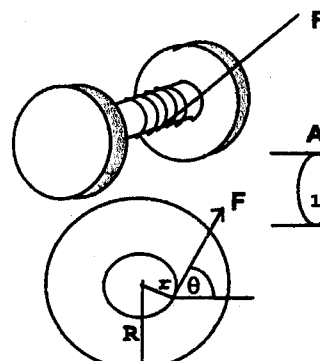


Fig-3

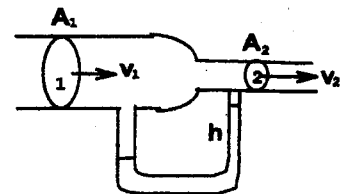


Fig-4

(背面仍有題目,請繼續作答)

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10%(6): (a) State Gauss's law.(3%)

(b) The electric field can expressed in rectangular coordinate as $\vec{E} = \hat{i}(2x^2 + 5) \text{ C/N}$. Find the net charge contained in the cubic as shown in the Fig.5.(7%)

10%(7): In Fig.6, An infinity wire \overline{AB} carry a current I , the current is upward and increasing steadily at a rate di/dt . Beside the wire, there is a rectangular loop with sides ℓ and w , and two sides of the loop parallel to the wire. Find the magnetic flux passing through the loop, and what is the induced emf in the loop?

10%(8): Fig.7 shows the Young's double slits experiment, the separation between two slits is d , the wavelength of the incident light is λ , there are interference pattern on the screen.

(a) Show that the positions of center of the dark fringes are given by

$$d \sin \theta = (m + \frac{1}{2})\lambda \quad (m \text{ is an integer}) \quad (4\%)$$

(b) Show that the intensity of the fringes at screen is given by

$$I = I_0 \cos^2 \left(\frac{\pi d \sin \theta}{\lambda} \right)$$

where I_0 is the intensity at the center of the screen O. (6%)

10%(9): Monochromatic light of wavelength 450nm ($1\text{nm} = 10^{-9}\text{m}$) is incident on a clean Na surface of work function $\phi = 3.7 \times 10^{-19}\text{J}$. Determine

- (a) the energy of a photon of this light.(Planck's constant $h = 6.63 \times 10^{-34}\text{J} \cdot \text{S}$)(2%)
- (b) the maximum kinetic energy of the emitted electrons.(3%)
- (c) the threshold frequency for Na.(3%)
- (d) the magnitude of the momentum of a photon in the incident light.(2%)

10%(10): A particle of mass m is confined in an infinity potential well between $0 \leq x \leq L$, that is

$$U(x) = \begin{cases} 0 & \text{for } 0 \leq x \leq L \\ \infty & \text{otherwise} \end{cases}$$

- (a) Use the Schrödinger equation to find the possible energies of the particle.(5%)
- (b) If the particle is in ground state, what is the probability of finding the particle lies between the interval $0 \leq x \leq \frac{L}{3}$.(5%)

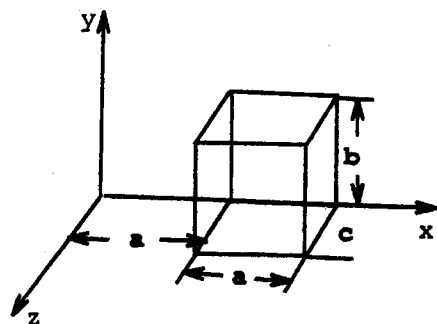


Fig-5

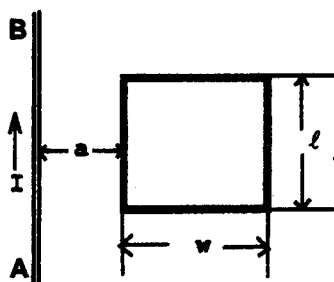


Fig-6

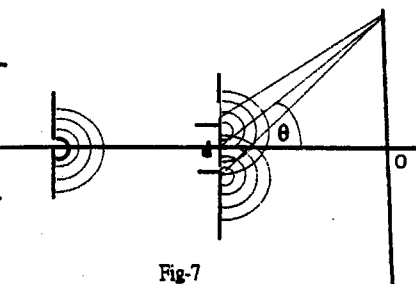


Fig-7