

\*\*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!

**Part one, single choice:** (40%, 每題5%) 不倒扣

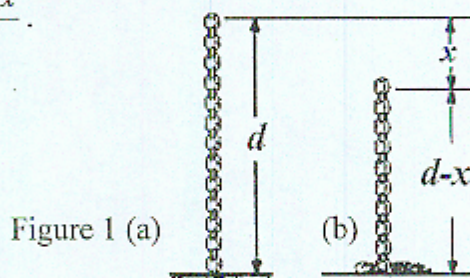
1.  $n$  moles of Ar gas changes from an initial state  $(P_0, V_0, T_0)$  to a final state  $(P_0/3, 3V_0, T_0)$  by a sudden, irreversible, free expansion. If  $C_v$  and  $C_p$  are the molar specific heats at constant volume and pressure, respectively, and  $\gamma = C_p/C_v$ . Then the change of the entropy during this process is (A) 0, (B)  $nR \ln 2$ , (C)  $nR \ln 3$ , (D)  $\gamma nR \ln 3$ , (E)  $(\gamma-1)nR \ln 3$ .

2. A rope of total mass  $m$  and length  $d$  is suspended vertically. The time  $t$  for a transverse wave pulse to travel the entire length of the rope is

(A)  $\sqrt{\frac{d}{g}}$ , (B)  $\sqrt{\frac{2d}{g}}$ , (C)  $2\sqrt{\frac{d}{g}}$ , (D)  $\sqrt{\frac{d}{2g}}$ , (E)  $\frac{1}{2}\sqrt{\frac{d}{g}}$ .

3. A chain of length  $d$  and total mass  $m$  is released from rest with its lower end just touching the top of a table, as in Figure 1a. Assume each link comes to rest the instant it reaches the table, then the force exerted by the table on the chain after the chain has fallen through a distance  $x$ , as in Figure 1b, is

(A)  $\frac{3mgx}{d}$ , (B)  $\frac{2mgx}{d}$ , (C)  $\frac{mgx}{d}$ , (D)  $\frac{mgx}{3d}$ , (E)  $\frac{3mgx}{2d}$ .



4. The potential energy of the two atoms in a diatomic (two-atom) molecule can be written

$U(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$  where  $r$  is the distance between the two atoms and  $a$  and  $b$  are positive constants. The binding energy of a two-particle system is defined as the energy required to separate the two particles from their state of lowest energy to  $r = \infty$ . Find the binding energy for the molecule:

(A)  $\frac{a^2}{2b}$ , (B)  $\frac{2a^2}{b}$ , (C)  $\frac{4a^2}{b}$ , (D)  $\frac{a^2}{4b}$ , (E)  $\frac{a^2}{b}$ .

5. A rod of length  $L$  has a total charge  $Q$  uniformly distributed over the rod. Find the force acting by  $Q$  on a charge  $q$ , which is located along the long axis of the rod and a distance  $d$  from one end of the rod.

(A)  $q(Q/L)/(4\pi\epsilon_0 d)$ , (B)  $qQ/[4\pi\epsilon_0 L(L+d)]$ , (C)  $q(Q/L)/[4\pi\epsilon_0 L(L+d)]$ , (D)  $qQ/[4\pi\epsilon_0 d(L+d)]$ , (E)  $qQ/(\epsilon_0 dL)$ .

6. What is the capacitance of an isolated charged metal sphere which has radius  $R$ ?

(A)  $4\pi R\epsilon_0$ , (B)  $R/4\pi\epsilon_0$ , (C)  $(4\pi/3)R^3\epsilon_0$ , (D)  $4\pi R^2\epsilon_0$ , (E)  $4\pi R^2/\epsilon_0$ .

國立交通大學 96 學年度碩士班考試入學試題

科目：普通物理(4012)

考試日期：96 年 3 月 18 日 第 3 節

系所班別：電子物理學系

組別：電物所甲組

第 2 頁, 共 3 頁

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7. Molybdenum has a work function of 4.20 eV. What is the stopping potential if the incident light has a wavelength of 200 nm?  
 (A) 26 V, (B) 8.4 V, (C) 2.0 V, (D) 1.0 V, (E) 0.1 V.
8. A student uses a microscope to observe micro-structures. The wavelength of the illumination light is 600 nm. The aperture of the objective has a diameter of 1.22 cm. What is the limiting angle of resolution?  
 (A) 2 degree, (B)  $5 \times 10^{-5}$  degree, (C)  $6 \times 10^{-5}$  rad, (D) 732 rad, (E)  $2 \times 10^5$  rad.

**Part two, problems:** (60%, 每題 15%)

9. A solid sphere of radius  $R$  and mass  $M$  is placed in a cylindrical trough (radius =  $5R$ ), as shown in Figure 2. The sphere is released from rest at a **small** angle  $\theta_0$  to the vertical and rolls without slipping. The rolling direction is perpendicular to the length of the trough.
- (a) **Show** that the magnitude of the angular speed of the sphere can be expressed as  $|\omega| = 4 \frac{d\theta}{dt}$  (3%).
- (b) **Determine** the angular speed of the sphere when it reaches the bottom of the trough (3%).
- (c) **Find** the equation of motion for  $\theta$  (5%).
- (d) **Show** that the sphere executes simple harmonic motion and **find** the period  $T$  of the simple harmonic motion. (4%)

Notes: (1) The moment of the inertia of a solid sphere about its symmetry axis is  $I = 2/5 MR^2$ .

(2)  $\sin \theta = \theta - \theta^3/3! + \theta^5/5! - \dots$

$\cos \theta = 1 - \theta^2/2! + \theta^4/4! - \dots$

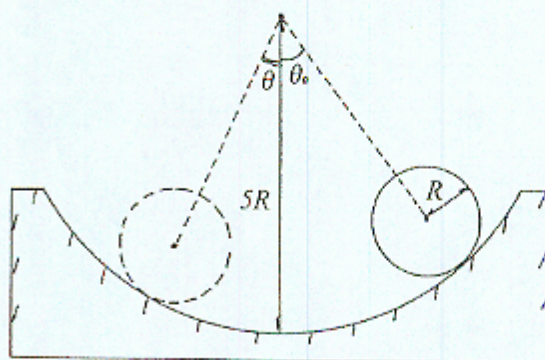


Figure 2

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10. Suppose a person of mass  $m = 6.5 \times 10^1 \text{ kg}$  is running at a speed  $v = 3.8 \text{ m/s}$  and has a catabolic (分解代謝) power output (that is, rate of internal energy consumption)  $9.45 \times 10^2 \text{ W}$  during a  $1.0 \times 10^1 \text{ km}$  workout. Suppose the runner converts 20% of the internal energy change into mechanical work. The rest of the energy goes into heat. If the specific heat of the runner is  $c = 4.19 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$ , **how much** would the body temperature rise after running the  $10 \text{ km}$ ? (15%)
11. A series RLC circuit has  $R = 200 \text{ } \Omega$ ,  $L = 250 \text{ mH}$ , and  $C = 10.0 \text{ } \mu\text{F}$ . The applied voltage has an amplitude of  $50.0 \text{ V}$  and an angular frequency ( $\omega$ ) of  $1000 \text{ Hz}$ . Find the following amplitudes: (a) The current  $I_{\text{max}}$ , (b) the voltage  $\Delta V_c$  across the capacitor and its phase relative to the current, and (c) the voltage  $\Delta V_L$  across the inductor and its phase relative to the current. (15%)
12. A conducting rod of length  $\ell$  moves with velocity  $v(t) = 5t \text{ (m/s)}$  parallel to a long wire carrying a steady current  $I$ , where  $t$  is in second. The axis of the rod is maintained perpendicular to the wire with the near end a distance  $r (= \ell)$  away. Find the emf induced in the rod at  $t = 3$  second. (15%)