國 立 清 華 大 學 命 題 紙

八十六學年度轉學生入學考試

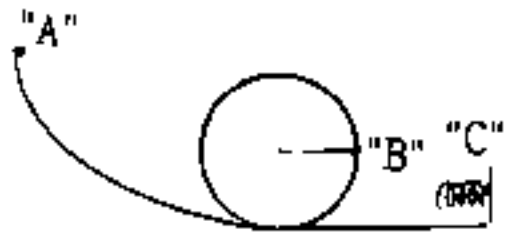
科目 普通物理 共 4 頁第 1 頁 *請在試卷【答案卷】內作答

(acceleration of gravity $g=9.8m/s^2$, $1atm=10^5pa$,gas constant $R=8.314$ J/Kmol,ln2=0.693)

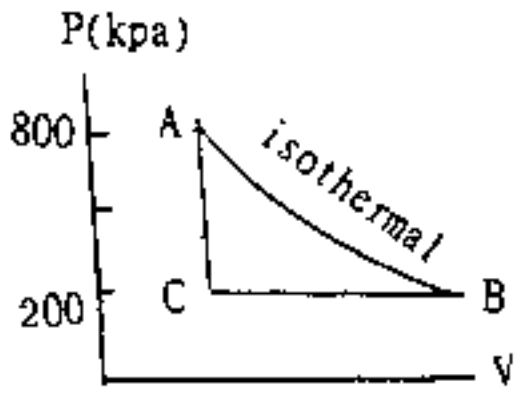
I. 計算題 :

1. (10%)From Schrödinger equation, derive the wavefunctions and energies of a particle of mass m in a one-dimensional box of length L.

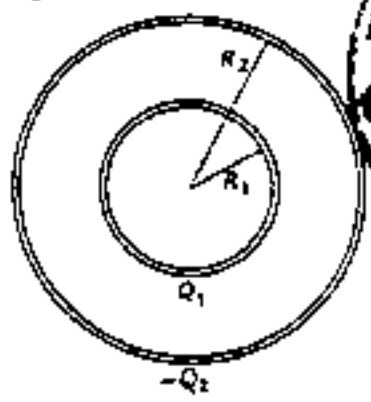
2. (10%)A small body of mass 0.1 kg slides from rest at "A" without friction around the loop-the-loop apparatus shown in Fig.1-2. The radius of the loop is 0.2m. Suppose the small body being able to complete the loop. (a) What is the minimum height of point "A" above the bottom of the loop ?
With "A" being at the minimum height, answer the following two questions.
(b) What are the radial and tangential accelerations of the small body when it reaches point "B" at the end of a horizontal diameter of the loop ?
(c) If the force constant of the spring at the end point "C" is 100 N/m, What is the compressed length of the spring by the hit of the small body ?



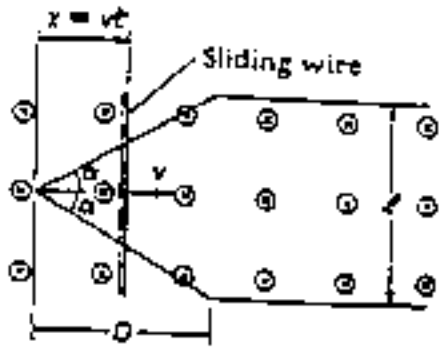
3. (10%)Two moles of an ideal gas are carried around the thermodynamic cycle shown in Fig.1-3. The cycle consists of (1) an isothermal expansion A → B at temperature of 800 K, with the pressure at A given by p_A= 8 atm; (2) an isobaric copression B → C at 2 atm; and (3) an isochoric pressure increase C→ A.
What work is down and entropy is changed by the gas per cycle ?



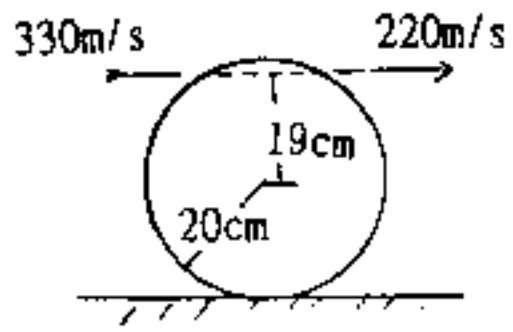
4. (10%)A metal sphere of radius R_1 has a charge Q_1. It is enclosed by a conducting spherical shell of radius R_2 that has a charge $-Q_2$; see Fig.1-4. Determine:
(a)the potential V_1 of the inner sphere;
(b)the potential V_2 of the outer sphere;
(c)under what condition is $V_1 = V_2$?



5. (10%)Consider the sliding-wire circuit shown in Fig 1-5 .
The wire slides at constant speed v and the plane of the circuit is perpendicular to a uniform magnetic field B. Show that the induced emf is given by $\xi = Blv^2t/\mathrm{D}$ for $0 < t < D/v$. What is the expression for the emf for $t > D/v$?



6. (11%)A bullet of mass 4.0 g and velocity 330 m/s passes through a wheel at rest on a rough floor. The wheel is a solid disk of mass 2.0 kg and radius 20 cm. The bullet passes through the wheel at a perpendicular distance of 19 cm from the center, and the bullet's final velocity is 220 m/s. If the wheel rools without slipping, find the wheel's
(a) angular velocity,
(b) angular momentum about the axis along the center of the wheel and
(c) kinetic energy.
(d) Is the energy of the motion conserved ?



2. 選擇題 :

**** (Indicate a,b,c,d or e in your answer sheet) ****

1. (3%)When a satellite is expected to escape from the earth (mass M, radius R), its lunching velocity must be equal to or larger than
(a) $\sqrt{GM/2R}$. (b) $\sqrt{GM/R}$. (c) $\sqrt{2GM/R}$.
(d) $\sqrt{3GM/R}$. (e) none of the above. (G the universal gravitational constant)

2. (3%)A boy sits on a turntable which is rotating with an angular velocity of 60 revolutions per minute. He is holding at arm's length two bricks. Suddenly he releases the bricks. Which of the following best describles the motion of the boy soon after he drops the bricks ?
(a) His angular velocity remains the same as it was.
(b) His angular velocity decreases.
(c) His angular velocity increases.
(d) His angular velocity cannot be determined without additional information.
(e) none of the above.

3. (3%)An empty wagon of mass M is started with velocity V_o during a rainstorm on a windless day. If the wagon collects water at rate of r pounds per second, the velocity after a time t is
(a)$V_o(1+\frac{rt}{M})^{-1}$. (b)$V_o(1+\frac{rt}{M})^{-1/2}$. (c) V_o.
(d) $V_o e^{-rt/M}$. (e) none of the above.

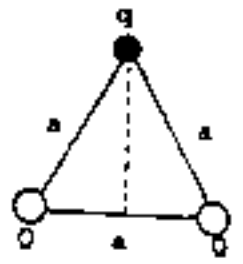
4. (3%)A stationary underwater sound source operates at a frequency of 3×10^4 cycles/sec. A surmarine when moving directly toward the source detects a frequency 100 cycles/sec higher than that picked up when the submarine is stationary. How fast is the submarine moving ? The velocity of sound in water can be taken as 1.5×10^3 m/sec.
(a) 10 m/sec. (b) 5 m/sec. (c) 1 m/sec.
(d) 0.5 m/sec. (e) none of the above.

5. (3%)A block of ice of mass M, and latent heat of fusion L rests on a frictionless surface. a bullet of mass m and velocity V (parallel to the frictionless surface) strickes the block on the ice and becomes inbedded in it. Assume negligible heat capacity for the bullet, how much of the ice will be melted ?
(a) $\frac{(M+m)^2V^2}{2mL}$. (b) $\frac{m^2V^2}{ML}$. (c) $\frac{mMV^2}{2L(m+M)}$.
(d) $\frac{MV^2}{L}$. (e) none of the above.

6. (3%)A container holding a certain amount of an ideal gas is connected by a pipe with a valve to an empty container. The two tanks are thermally insulated from the suroundings. Opening the valve it is found that
(a) both the temperature and the pressure of the gas remain unchanged
(b) both the temperature and the pressure of the gas decrease.
(c) the temperature of the gas decreases, the pressure remaining unchanged.
(d) the pressure of the gas decreases, the temperature remaining unchanged.

7. (3%)It is desired to measure the moment of inertia of a metal disc. Its radius and mass were measured, M=100± 2 gm, R=5.0±0.15 cm. Where the probable errors are given. What is the probable percentage error in the calculated moment of inertia ? (the root-mean-square error is desired.)
(a) 5%. (b) 10%. (c) 8%.
(d) 6%. (e) none of the above.

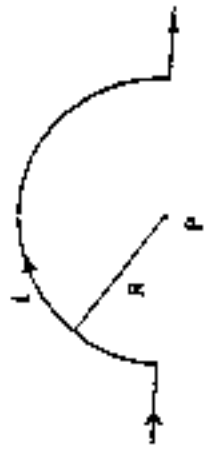
8. (3%)The two charges Q are fixed at the vertices of an equilateral triangle. If $k=1/4\pi\varepsilon_o$, the work required to move q from the other vertex to the center of the line joining the fixed charge is :



(a) zero. (b) kQq/a.
(c) kQq/a^2. (d) 2kQq/a. (e) $\sqrt{2}$kQq/a.

9. (3%)Electrons (mass m, charge -e) are accelerated from rest through a potential difference V and are then deflected by a perpendicular magnetic field B. The radius of the resulting electron trajectory is:
(a) $\sqrt{2eV/m}/B$. (b) $B\sqrt{2eV/m}$. (c) $(\sqrt{2mV/e})/B$.
(d) $B\sqrt{2mV/e}$. (e) none of these.

10. (3%)The magnitude of the magnetic field at the center P of the semicircle shown below is given by :



(a) $\mu_o i/R^2$. (b) μ_oi/2 R.
(c)μ_oi/4 R. (d) μ_o i/2R.
(e) μ_oi/4R.

11. (3%)The emf that appears in Faraday's law is:
(a) around a conducting circuit.
(b) around the boundary of the surface used to compute the magnetic flux.
(c) throughout the surface used to compute the magnetic flux.
(d) perpendicular to the surface used to compute the magnetic flux.
(e) none of the above.

12. (3%)Consider the four Maxwell equations:
I. $\oint \vec{E} \cdot d\vec{S} = q/\varepsilon_o$ III. $\oint \vec{E} \cdot \vec{dl} = -d\phi_B/dt$
II. $\oint \vec{B} \cdot d\vec{S} = 0$ IV. $\oint B \cdot \vec{dl} = \mu_o\varepsilon_o d\phi_B/dt + \mu_o i$
Which of these would have to be modified if magnetic poles were discover :
(a) only I. (b) only II. (c) only II and III.
(d) only III and IV. (e) only II,III and IV.

13. (3%)The radius r_n of a hydrogen atom, according to Bohr theory, depends on n as follows:
(a) $r_n \propto$ n. (b) $r_n \propto n^2$. (c) $r_n \propto 1/n$.
(d) $r_n \propto 1/n^2$. (e) $r_n \propto \sqrt{n}$.