

Master Entrance Examination in General Physics.

(I) Calculate the following problems. (70%).

[1] Particle m in Fig. 1 slides down the frictionless surface and collides with the uniform vertical rod, sticking to it. The rod pivots about O and rotates through the angle θ before coming to rest. Calculate (a) the moment of inertia of the rod about an axis perpendicular to the paper and passing through O ; (b) the velocity of the particle at the bottom of the rod just before collision; (c) the initial angular velocity of the rod after collision; and (d) θ , in terms of the other parameters given in the figure. (4,4,4,4)%

[2] (a) Find the potential, in terms of ϵ_0 , θ , p , and r , due to a dipole (see Fig. 2) with a dipole moment $p=2aq$ at a distance r from its center with $r \gg a$. (b) Find the components of the electric field E_r , E_θ , along the \hat{r} and $\hat{\theta}$ directions. (4,6)%.

[3] A dipole with a magnetic moment μ is freely pivoted at its center and has a moment of inertia I about this axis. For small angular displacements θ , the dipole will execute simple harmonic motion in a uniform magnetic field B . (a) Find the equation of motion for the dipole, (the differential equation for θ). (b) What is the period of oscillation? (c) If the initial conditions for the angular displacement and angular velocity are $\theta(0)=\theta_0$, $\dot{\theta}(0)=0$ respectively, find the solution for $\theta(t)$, angular displacement as a function of time. (4,4,8)%.

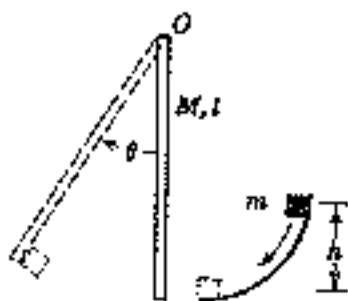


Fig. 1.

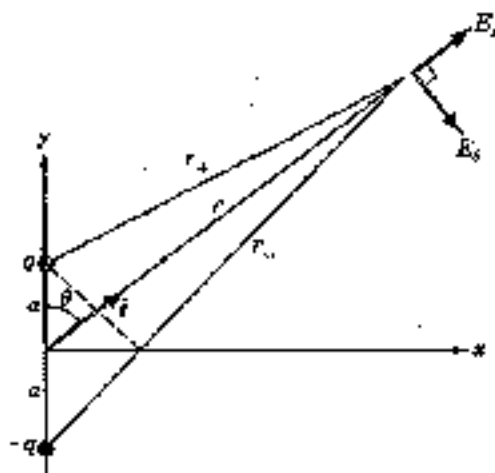


Fig. 2.

八十四學年度 物理研究 所應用物理組碩士班研究生入學考試

科目 普通物理 科號 0502 共 3 頁第 2 頁 *請在試卷【答案卷】內作答

[4] A metal bar of mass m , length ℓ , and resistance R slides down a pair of frictionless rails of negligible resistance inclined at angle θ to the horizontal; see Fig. 4. A uniform magnetic field B is directed vertically upward. (a) Obtain an expression for the current induced in the rod. Assume that the rails have no resistance. (b) Find the terminal speed, in terms of m , g , R , θ , B and ℓ , the rod can attain. (4,6)%.

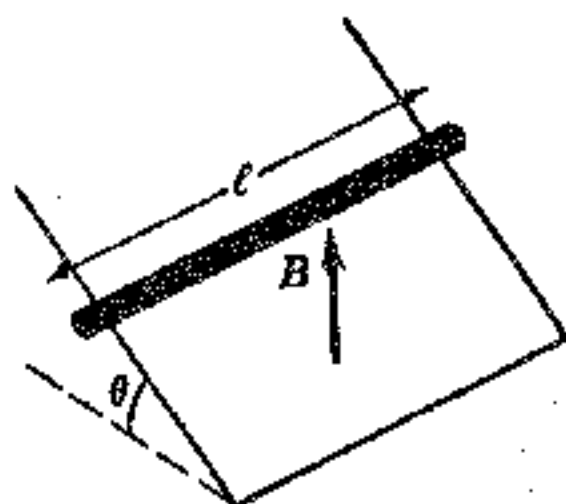


Fig. 4.

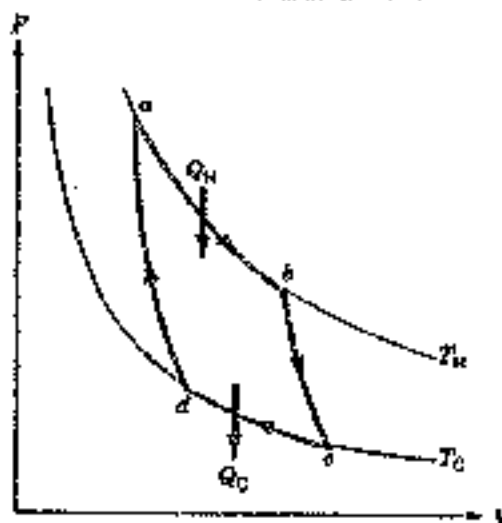


Fig. 5

[5] The Carnot cycle, shown in Fig. 5, operates for n mole of ideal gas. Find (a) Q_H , in terms of n , R , V_a , V_b and T_H , in the isothermal process a to b; (b) Q_C , in terms of n , R , V_c , V_d and T_C in the isothermal process c to d; (c) the work done, in terms of P_b , V_b , P_c , V_c , C_p and C_v , in the adiabatic process b to c; (d) the work done, in terms of n , C_v , T_H and T_C , in the adiabatic process d to a; (e) the Carnot efficiency in terms of T_H and T_C ; and (f) the entropy change, in terms of n , R , V_b and V_a , in the isothermal process from a to b, where P , V , Q , T , C , indicate pressure, volume, heat, temperature and molar specific heat at the specified state respectively, and R is the universal gas constant. (3,3,3,3,3,3)%.

(II) Fill the following blanks. Only the number and your correspondent answer should be written in your answer sheet. In some questions, you should choose one most probable answer in parentheses. (30%; 3% for each blank)

八十四學年度 物理研究 所應用物理組碩士班研究生入學考試

科目 普通物理 科號 0502 共 3 頁第 3 頁 *請在試卷【答案卷】內作答

- 1] The electric field strength E at a distance R from an infinite line of charge with linear charge density λ C/m is (1).
- 2] The magnetic field strength B at a distance R from an infinite straight wire that carries a current I is (2).
- 3] A large tank is filled with water to a height of h . The bottom of the tank has a hole. The speed of the water emerged out of the hole is (3).
- 4] Below the critical temperature, the resistivity of a superconductor drops to (4) (very small positive value, zero, or a constant negative value).
- 5] The momentum of an isolated system is always (5) (zero, conserved, or nonconserved).
- 6] An accelerated charge will (6) (absorb, radiate, rotate, or translate) electromagnetic waves.
- 7] An electromagnetic wave propagates in the laboratory. Usually electric field E , instead of magnetic field B , is measured, because E is equal to (7) times B .
- 8] The most probable number of photons that can be produced in the annihilation of electron and positron is (8) (one, two, three, or four).
- 9] In an elastic two dimensional collision of two identical particles, the two particles move apart at (9) (30, 45, 60, or 90,) degrees after collision, if the moving particle collides with the initially rest particle in the same plane.
- 10] From the physical point of view, the meaning of "man is mortal" is a consequence of (10) (conservation of energy and mass, conservation of charge, increasing entropy, or conservation of mass) in the universe.