國立中央大學 106 學年度碩士班考試入學試題

所別： 天文研究所 碩士班 不分組(一般生)
天文研究所 碩士班 不分組(在職生)

科目： 普通物理

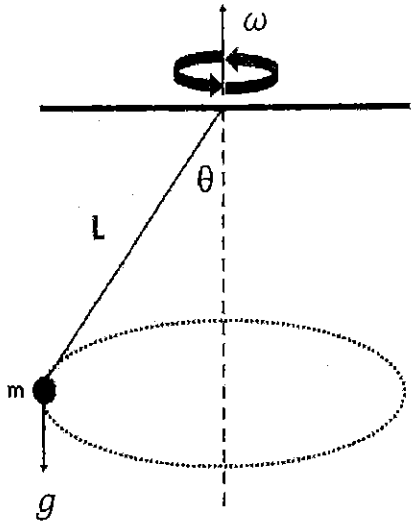
本科考試禁用計算器

＊請在答案卷 內作答

須有計算過程

參考用

1. (20%) A conical pendulum, fixed on one end of a light inextensible string of length L with a suspended object of mass m experiencing a gravitational acceleration g, moves at a constant speed v in a horizontal circle with the string tracing out a cone, as shown on the right.



(a) What is the tension force in the string (5%)? (b) What is the angular speed ω of the motion (5%)? (c) Write down, but do not solve, the equation of motion of the object (5%). (d) If the air friction is now considered, with the drag force proportional to the speed, i.e., $F_D = \gamma v$, where γ is the viscosity. Write down the equation of motion in this case (5%).

2. (20%) (a) The temperature of an ideal gas with constant heat capacity changes from T_1 to T_2. Show that the entropy change ΔS of the gas is greater if the change in state occurs at constant pressure than if at constant volume (10%). (b) Water of mass m_1 and temperature T_1 is mixed with another water of mass m_2 and temperature T_2. What is the equilibrium temperature and the entropy change of the mixture process (10%)?

注意：背面有試題

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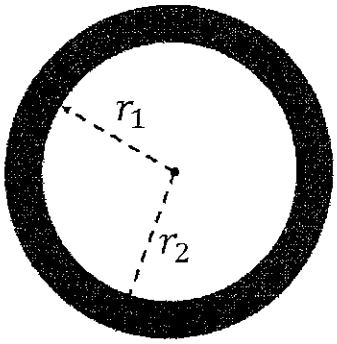
3. (40%) A spherical shell has an inner and an outer radius of r_1 and r_2, respectively, as depicted on the right. The shell is equally charged with a volume charge density q and with a uniform material density ρ.



(a) Find the gravitational potential energy, and the electric potential energy everywhere in space, i.e., for $r < r_1$, $r_1 \leq r \leq r_2$, and $r > r_2$ (20%). (b) Consider a different situation for which this spherical body moves at a constant speed v. What is the magnetic field in space where $r \gg r_2$ (10%)? (c) Does this uniformly moving body produce any electromagnetic radiation? Why or why not? What if instead of a constant speed the body accelerates (10%)?

4. (20%) For simple harmonic motion, the restoring force on a particle of mass m is $F = -kx$, where x is the displacement from the equilibrium position, and k is a constant. (a) Find the period of the motion (10%). (b) Write down the Schrödinger wave equation for the simple harmonic oscillator with potential energy $U = {}^1/_2\, m\omega^2 x^2$, and at an energy state $E = \hbar\omega/2$ (10%). Show that $\psi = Ae^{-Bx^2}$ is a solution, and evaluate B (10%).