所別：物理學系碩士班 一般生 科目：古典物理

學位在職生

You must show the procedures of your calculation, or you won't get the full credit.

1. (a)Assume a spherical earth of a mass M, a radius R, and the gravitational acceleration constant = g. For someone who lives on the Earth's surface at a northern latitude λ, point out the deviation (including the direction and the magnitude) of the direction of g from the true vertical (i.e., toward the center of the Earth). (8%)
   (b) Is there any cyclone taking place right on the equator? Explain why. (7%)

2. Two spheres are of the same diameter and same mass, but one is solid and the other is a hollow shell. Describe a nondestructive experiment to determine which is which. (5%)

3. A particle of mass m is confined to move in a vertically circular loop of mass M with a radius R, which in turn can roll on the floor (due to friction) as shown on Figure 1. Assume the gravitational acceleration constant =g.
   (a) Write down the *Lagrangian* and *Hamiltonian* of this system. (5%)
   (b) Obtain the equation(s) of motion for this system. (5%)
   (c) What is the friction between the loop and the floor? (5%)

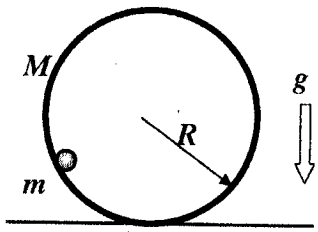

Figure 1

4. (a) Write down the equation of motion for a damped oscillator vertically placed in a constant gravitational field g. (3%)
   (b) Write down the equivalent equation for a RLC circuit, and plot the corresponding circuit diagram. (4%)
   (c) What is the mechanical quantity in (a) equivalent to V_L (i.e., the voltage across the electrical inductor) in (b)? (3%)

5. Show that the dipole moment of an arbitrary charge distribution is independent of the choice of origin, provided the net charge in the distribution is zero. (7%)

6. For a parallel-plate capacitor (of area A and plate separation s) immersed in a liquid dielectric (with the dimensionless dielectric constant ϵ_r), find out the electrostatic force acting on the plates if they are connected to a battery of a constant voltage V. (8%)

7. (a) For an ideal gas undergoing an adiabatic process, show that PV^{γ}=**constant** for $\gamma=C_p/C_v$ (where C_p and C_v are the heat capacity at constant pressure and volume, respectively. (7%)
   (b) Derive the efficiency of a Carnot engine using an ideal gas as the working substance. (8%)

8. (a) Define the *partition function* Z and the *Helmholtz free energy* F. (5%)
   (b) Write down the relation between Z and F. (5%)

注意：背面有試題

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9. (a) For a uniformly magnetized cylinder, sketch the lines of $\vec{B}$ (with solid lines "——") and the lines of $\vec{H}$ (with broken lines "- - - -") on a side view like Figure 2. (Do not forget to attach arrows along the lines to indicate the directions.) (5%)
   (b) An "electret" is the electric equivalent of a "bar magnet" like (a). For a uniformly polarized bar electret, sketch the lines of $\vec{E}$ (with solid lines "——") and the lines of $\vec{D}$ (with broken lines "- - - -") on a side view like Figure 3. (Do not forget to attach arrows along the lines to indicate the directions.) (5%)
   (c) Comment on the comparison between (a) and (b). (5%)

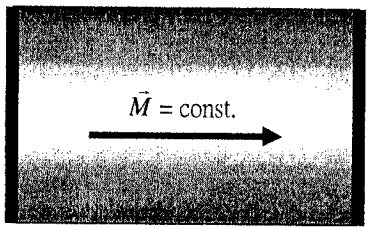

Figure 2

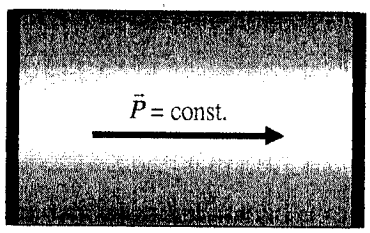

Figure 3