國立臺灣師範大學 104 學年度碩士班招生考試試題

科目：**普通物理**　　適用系所：**物理學系**

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

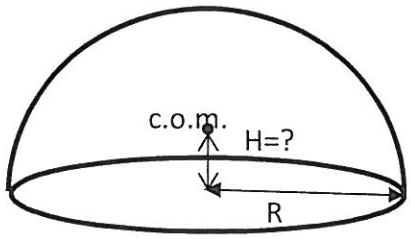
1. (a) Derive that the specific heat of constant volume "C_v" = **3R/2**, and the specific heat of constant pressure "C_p" = **5R/2** for monatomic ideal gas. (Note: R is the ideal gas constant.) (10 points)

   (b) Derive that in an adiabatic process, $P \cdot V^{\gamma}$ =constant. $\gamma \equiv {}^{C_p}/_{C_v}$. (5 points)

2. (a) Explain what is "Carnot's Cycle" or "Carnot's Engine". Plot the cycle in a **P-V** diagram. (10 points)

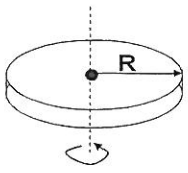
   (b) If a Carnot's engine is operated between the hot temperature T_h and the cold temperature $T_c = T_h/2$. Calculate the efficiency of the Carnot's Engine = ? (5 points)

3. What is the height of the center of mass in a half spherical wood? (Note that the mass distribution is uniform and the radius equals "**R**". (10 points)



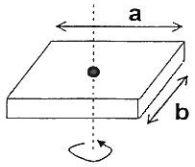
4. Derive the following rotational inertia for the objects (mass=M). (10 points x 2)

(a) disc



$I=(MR^2)/2$

(b) rectangular plate



$I=M(b^2+a^2)/12$

5. Propose a method to measure the carrier density in a piece of semiconductor. Explain the mechanism applied in this method. (Hint: you may apply an electric current and a magnetic field to the semiconductor.) (10 points)

6. There is a thick metallic spherical shell with the inner radius = $\mathbf{R_i}$ and outer radius = $\mathbf{R_o}$. The net charge of this shell is zero. There is a point charge **+Q** in the center of spherical shell.
   (a) How is the charge distribution in the metallic shell? Calculate its surface or volume charge density. (5 points)
   (b) Calculate and plot the electric field **E(r)** for r=0 ~ ∞. (Note: r is the distance to the center of this spherical shell.) (5 points)
   (c) Calculate and plot the electrical potential **Φ(r)** for r=0 ~ ∞. (5 points)

7. (a) If a pendulum is suspended with a light string. The length of this string is **L** and the pendulum can be treated as a mass point. What is the length of **L** shall we choose in order to have the oscillation frequency = 1 /sec. (The gravitational acceleration g = 10 m/s^2.) (5 points)
   (b) When the light string and pendulum is replaced by a thin uniform rod, what is the length of **L** shall we choose in order to have the oscillation frequency = 1 /sec? (Note: The length of rod is **L**, and the mass is **m**. The gravitational acceleration g = 10 m/s^2.) (10 points)